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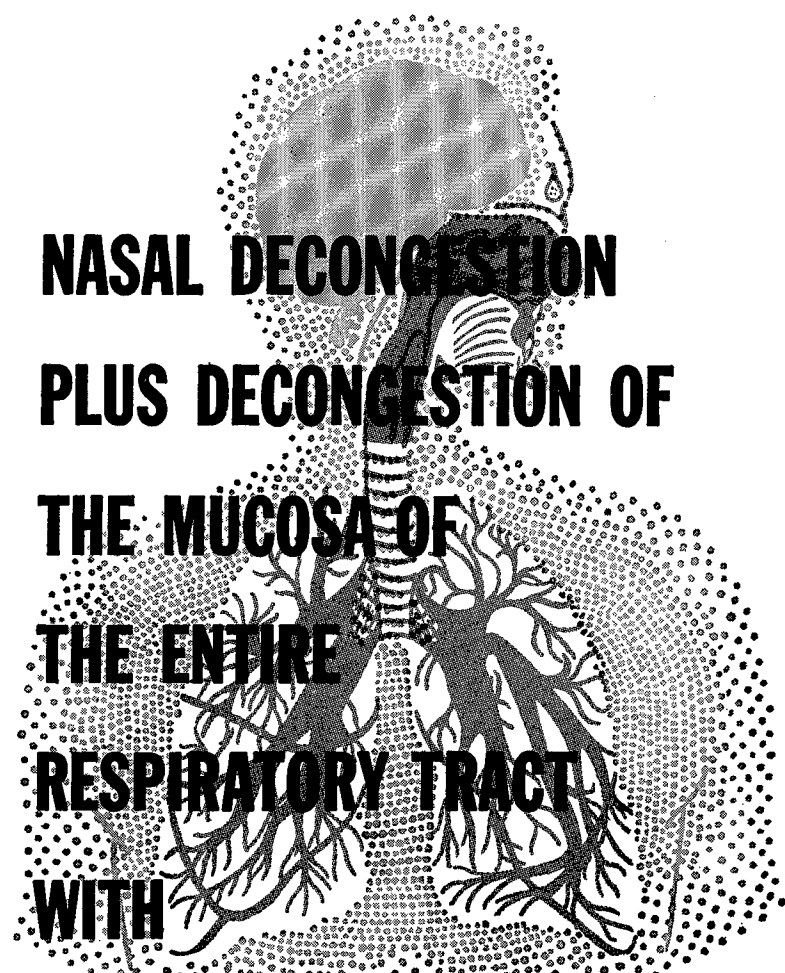
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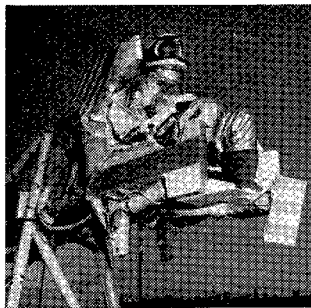
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Tertiary Blast Effects

Effects of Impact on Mice, Rats, Guinea Pigs and Rabbits

DONALD R. RICHMOND, PH.D., I. GERALD BOWEN, M.S., and CLAYTON S. WHITE, M.D.

TO SERVE the purposes of study and presentation, the biological effects of air blast have been arbitrarily divided into several categories, the most important of which are primary, secondary, and tertiary effects.³⁴⁻³⁷ Primary damage is that associated with variations in environmental pressure *per se*. Injuries generally occur where the variation in tissue density is the greatest, and in particular, involve the air-containing organs; e.g., the sinuses, ears, lungs, and gastrointestinal tract. When the lungs are significantly injured, widespread arterial air emboli ensue and frequently produce rapid mortality when blood flow in coronary and cerebral vessels is embarrassed.^{2,5,8,34-38}

Secondary effects include those injuries resulting from the impact of penetrating or non-penetrating missiles energized by blast pressures, winds, ground shock, and gravity. A wide variety of injuries is seen ranging from slight lacerations to penetrating and perforating lesions due to flying debris, including fragments of glass and other frangible materials. Also, massive, crushing injuries can occur from the collapse of inhabited structures of various types.

From the Departments of Comparative Environmental Biology, and Physics, Lovelace Foundation for Medical Education and Research, Albuquerque, New Mexico.

This work was initiated under the support of the Division of Biology and Medicine of the U. S. Atomic Energy Commission and completed under Contract No. DA-49-146-XZ-055 with the Defense Atomic Support Agency of the Department of Defense.

Tertiary effects encompass injuries that occur as a consequence of actual displacement of a biological target by winds that accompany the propagation of the pressure pulse. Though damage may ensue during the accelerative phase of movement because of differential velocities imparted to various portions of the body, trauma is likely to be more prevalent and severe during deceleration, particularly if impact with a hard surface occurs. Injuries in this category may be somewhat similar to those mentioned above for secondary effects and may frequently bear a resemblance to those observed in victims of automobile accidents,^{21,22} falls,⁶ and airplane crashes;^{19,32} e.g., abrasions, lacerations, contusions, fractures, and rupture of, and damage to, the internal organs, including the heart, lungs, liver, spleen, brain, and spinal cord.

Proper assessment of the tertiary blast hazard requires knowledge in at least two areas; namely (a) information concerning velocities attained by objects the size and shape of man in relation to the physical parameters of the blast wave, and (b) man's tolerance to impact as a function of striking velocity. The former has been studied by Taborrelli et al³¹ in full-scale nuclear tests, and Bowen and co-workers⁴ have formulated a mathematical model for predicting the velocity-history of objects as large as man when energized by blast pressures and winds from modern high-yield explosions. Relatively little, however, is known quantitatively about the biology of

decelerative impact referable either to humans or other mammals under circumstances wherein the stopping time and distance—other things being equal—are primary functions of the or-

of drop was measured from the ventral surface of the animal's trunk to the surface of the impact area.

TABLE I. ANIMALS USED IN THIS STUDY

| Species | Number | Mean Body Weight | Range | Standard Deviation |
|-------------|--------|------------------|-------------|--------------------|
| Mice | 113 | 19.8 g | (16-28) | 3.8 g |
| Rats | 178 | 185 g | (150-250) | 29 g |
| Guinea pigs | 111 | 650 g | (480-811) | 162 g |
| Rabbits | 53 | 2.43 kg | (1.62-3.63) | 0.47 kg |
| Total | 455 | | | |

ganism itself and not modified by other factors, such as deformation of vehicular structures, indentations in "soft" surfaces, and other events serving to depress the peak G load that develops during deceleration.

Because of this fact a relevant exploratory investigation using experimental animals was planned, carried out and the data assessed as one possible means of gaining some quantitative insight into the tolerance of man to impact. The following material will first describe the experiments performed; second, detail the observed "dose"-response relationship between velocity at impact and lethality for mice, rats, guinea pigs, and rabbits striking a flat concrete surface in the ventral position; third, set forth an inter-species comparison noting the association between average body weight and impact velocity responsible for mortality in each species; and last, briefly discuss the implications of the data with regard to extrapolation to the human case.

METHODS

Generation of Impact Velocities.—The necessary range of velocities was obtained by dropping animals from different heights onto a flat concrete slab. Animals were released, one at a time, from a small box hoisted by a cable-pulley system attached to a 54-foot pole. The bottom of the box was opened by means of a solenoid-operated mechanism. At lower heights some of the animals were released by hand. Animals were in the prone position when dropped and when they struck the concrete pad. The height

Animals.—In all, a total of 455 animals were dropped in this study; their mean body weights, standard deviation, and the weight ranges are given in Table I. There were 113 mice and 178 rats dropped at intervals between 15 feet and 54 feet; 111 guinea pigs from heights between 10 feet and 24 feet; and 53 rabbits between 12 feet and 28 feet.

The animals killed by impact were autopsied* as soon after death as possible, while survivors were sacrificed and autopsied after 24 hours. The mortality figures reported subsequently, therefore, represent lethality up to 24 hours.

Determination of Impact Velocities.—Initially, impact velocities were determined from the timing marks on a Fastax camera film record taken of the animals just before impact. Velocities so determined for animals dropped from several different heights showed that the four species did not attain the same velocity for a given height of fall. Since it was impractical to take motion pictures of all the animals at impact, it was necessary to derive equations that would allow the calculation of the impact velocities.

Details of the experimental procedure and the derivation of the equations are reported elsewhere.¹³ Briefly, the procedure was as follows:

An acceleration coefficient, alpha (α), was experimentally determined for freely falling objects including the four species of animals concerned here. Alpha was defined as the area presented to the wind stream times the object's drag coefficient divided by its mass. The following empirical relation between alpha and mass was obtained for small animal species:

$$\log \alpha = 0.01153 - 0.32400 \log m \quad (1)$$

where

$$\begin{aligned} \alpha &= \text{acceleration coefficient in ft}^2/\text{lb} \\ m &= \text{animal's mass in grams} \end{aligned}$$

*The gross pathology observed in the animals subjected to impact will be the subject of a separate report.

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The following relationship for impact velocity was also experimentally derived:

$$V = (2gH)^{1/2} \left[\frac{-\rho\alpha H}{(1 - e^{-\rho\alpha H})} \right]^{1/2} \quad (2)$$

where

V = impact velocity

g = acceleration of gravity

H = height of fall

ρ = air density

α = acceleration coefficient

TABLE II. THE RELATION BETWEEN MOUSE MORTALITY AND IMPACT VELOCITY

| Height of Drop ft | Impact Velocity ft/sec | Number Dead Over the Number Dropped | Mortality Per Cent |
|----------------------|---------------------------|--|-----------------------|
| 15 | 28.4 | 0/10 | 0 |
| 18 | 30.8 | 1/10 | 10 |
| 21 | 32.6 | 3/10 | 30 |
| 28 | 36.3 | 6/20 | 30 |
| 32 | 38.5 | 6/22 | 27 |
| 36 | 39.3 | 3/11 | 27 |
| 42 | 41.3 | 7/10 | 70 |
| 48 | 43.0 | 8/10 | 80 |
| 54 | 45.3 | 10/10 | 100 |
| Total | | 44/113 computed LD ₅₀ = 39.4 ft/sec | |

Thus, the alpha for each group of animals dropped at the different heights, as reported in Tables II through V, was calculated by substituting the appropriate mean mass (body weight) into equation (1). Solving equation (2) with the proper values of α , g , H , and ρ yielded impact velocities for each group. The values so obtained for impact velocities were carefully checked in individual animals for each species

TABLE III. THE RELATION BETWEEN RAT MORTALITY AND IMPACT VELOCITY

| Height of Drop ft | Impact Velocity ft/sec | Number Dead Over the Number Dropped | Mortality Per Cent |
|----------------------|---------------------------|--|-----------------------|
| 15 | 29.8 | 0/10 | 0 |
| 18 | 32.3 | 0/10 | 0 |
| 21 | 34.6 | 0/10 | 0 |
| 24 | 36.8 | 1/10 | 10 |
| 27 | 38.7 | 2/10 | 20 |
| 30 | 40.4 | 3/10 | 30 |
| 33 | 42.0 | 6/10 | 60 |
| 36 | 43.6 | 2/10 | 20 |
| 39 | 45.3 | 9/20 | 45 |
| 42 | 46.5 | 23/26 | 88 |
| 45 | 47.5 | 8/10 | 80 |
| 48 | 48.6 | 8/10 | 80 |
| 51 | 49.8 | 8/10 | 80 |
| 54 | 50.9 | 20/22 | 91 |
| Total | | 90/178 computed LD ₅₀ = 43.5 ft/sec | |

and were consistent with the data obtained using high speed photography.

RESULTS

Mortality.—The twenty-four-hour mortality data observed for mice, rats, guinea pigs, and

TABLE IV. THE RELATION BETWEEN GUINEA PIG MORTALITY AND IMPACT VELOCITY

| Height of Drop ft | Impact Velocity ft/sec | Number Dead Over the Number Dropped | Mortality Per Cent |
|----------------------|---------------------------|--|-----------------------|
| 10 | 24.8 | 0/10 | 0 |
| 12 | 27.0 | 2/10 | 20 |
| 13 | 28.1 | 0/4 | 0 |
| 14 | 29.1 | 1/10 | 10 |
| 15 | 30.0 | 4/10 | 40 |
| 16 | 30.9 | 6/12 | 50 |
| 17 | 31.9 | 5/10 | 50 |
| 18 | 32.7 | 8/10 | 80 |
| 19 | 33.6 | 8/11 | 73 |
| 20 | 34.4 | 9/10 | 90 |
| 21 | 35.1 | 10/10 | 100 |
| 24 | 37.2 | 4/4 | 100 |
| Total | | 57/111 computed LD ₅₀ = 31.0 ft/sec | |

rabbits are presented in Tables II, III, IV, and V, respectively. Each table gives the mortality associated with the height of the fall and the computed impact velocity over the range in lethality from near zero to about 100 per cent

TABLE V. THE RELATION BETWEEN RABBIT MORTALITY AND IMPACT VELOCITY

| Height of Drop ft | Impact Velocity ft/sec | Number Dead Over the Number Dropped | Mortality Per Cent |
|----------------------|---------------------------|---|-----------------------|
| 12 | 27.4 | 0/10 | 0 |
| 14 | 29.5 | 2/10 | 20 |
| 16 | 31.5 | 5/10 | 50 |
| 18 | 33.3 | 7/10 | 70 |
| 20 | 35.1 | 9/10 | 90 |
| 22 | 36.7 | 1/1 | 100 |
| 24 | 38.2 | 1/1 | 100 |
| 28 | 41.2 | 1/1 | 100 |
| Total | | 26/53 computed LD ₅₀ = 31.7 ft/sec | |

for each species. Thus, the empirical data establishes a "dose"-response relationship for each species of animal.

To further assess this relationship an appropriate program for a Bendix G-15 Computer was prepared to apply the probit analysis of Finney¹² to the data presented in Tables II through V.

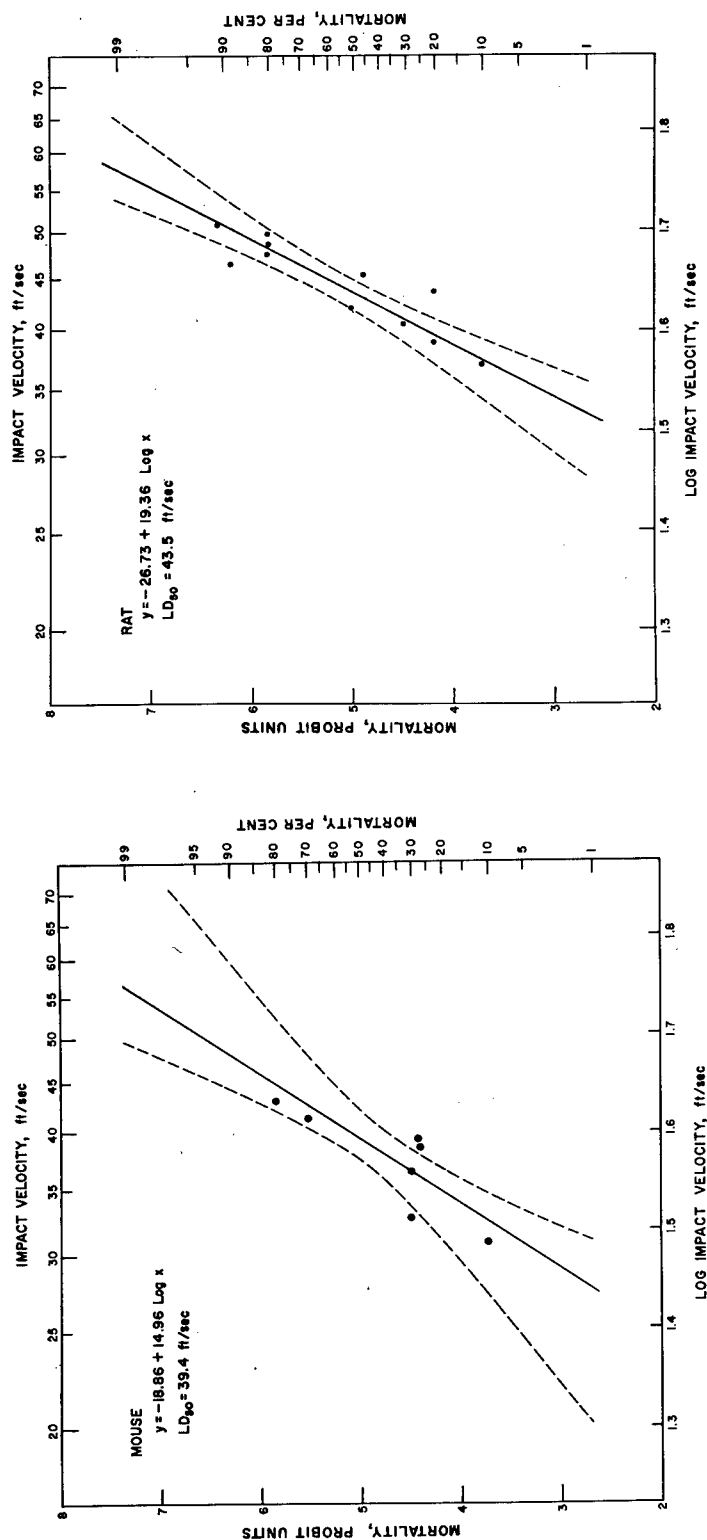


Fig. 1. (a) The relation between mouse, rat, guinea pig and rabbit mortality and impact velocity.

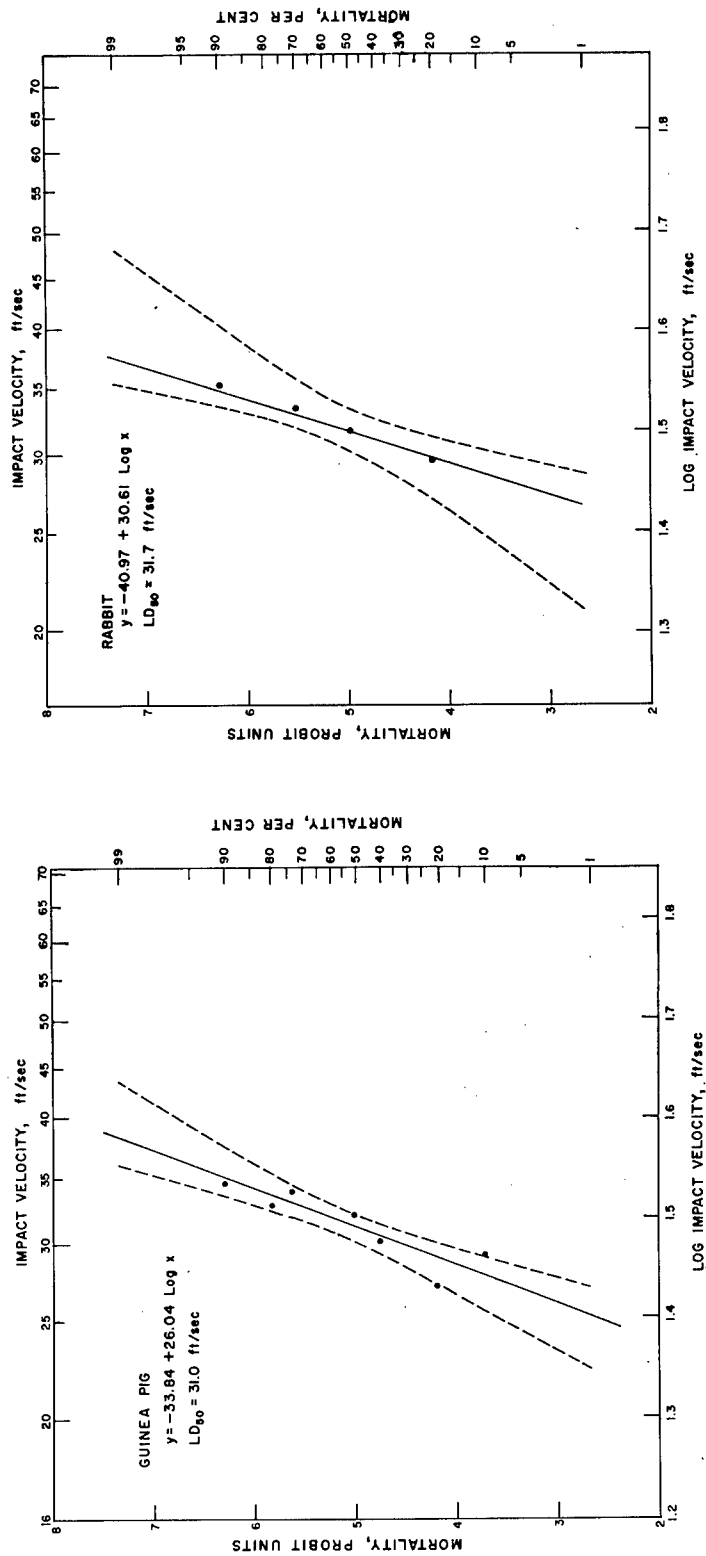


Fig. 1. (b) The relation between mouse, rat, guinea pig and rabbit mortality and impact velocity.

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The probit transformation relates the per cent mortality in probit units to the log of the "dose"—the "dose" here being the velocity at impact—and allows a sigmoid response curve to be

The results of the probit analyses are presented graphically for each species in Figure 1. Each part of Figure 1 notes the regression equation appropriate to the species of animal and

TABLE VI. RESULTS FROM THE PROBIT ANALYSIS

| Species of Animal | Impact Velocities, ft/sec, computed for*: | | | Probit Equation Constants** | | |
|-------------------|---|---------------------|---------------------|-----------------------------|----------|-------|
| | LD ₁₀ | LD ₅₀ | LD ₉₀ | a(intercept) | b(slope) | S(b)† |
| Mouse | 32.3 (27.2-34.6) | 39.4 (37.4-42.0) | 47.9 (44.1-59.4) | -18.86 | 14.96 | 3.02 |
| Rat | 37.4 (34.2-39.3) | 43.5 (42.0-44.8) | 50.7 (48.7-54.2) | -26.73 | 19.36 | 2.76 |
| Guinea pig | 27.7 (25.4-28.9) | 31.0 (30.0-31.9) | 34.7 (33.5-37.4) | -33.84 | 26.04 | 4.49 |
| Rabbit | 28.8 (25.0-30.3) | 31.7 (30.2-33.3) | 35.0 (33.3-40.1) | -40.97 | 30.61 | 7.08 |

*The numbers in parentheses are the 95 per cent confidence intervals.

**See Figure 1 for probit equations and graphic presentations.

†The standard error of the slope constant.

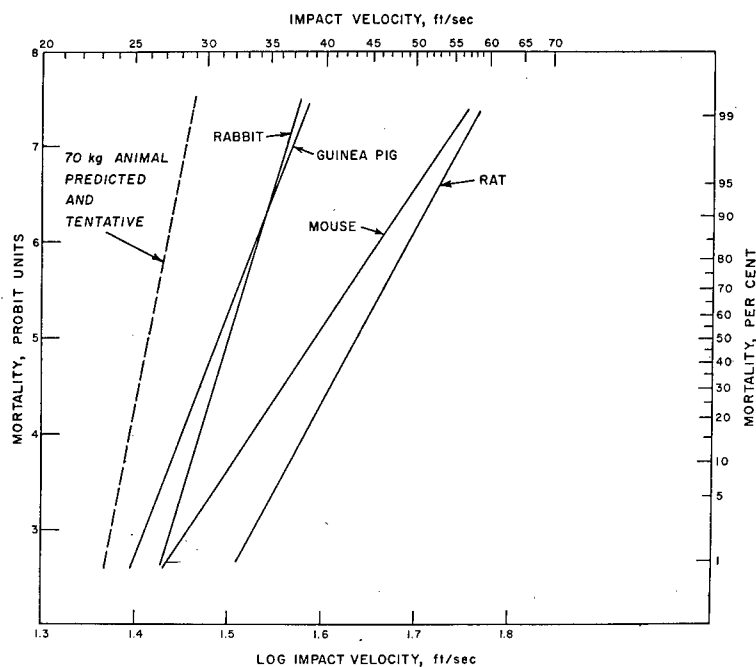


Fig. 2. Comparison of probit mortality curves.

expressed as a linear regression equation of the general form:

$$Y = a + b \log X$$

where

- Y = per cent mortality, in probit units
- X = velocity of impact in ft/sec
- a = constant for the intercept
- b = slope constant for the regression line

shows the regression line, the grouped individual data points, the 95 per cent confidence limits of the information and the LD₅₀ "velocity-dose" figure in feet per second which is that impact velocity associated with 50 per cent mortality obtained by substituting 5 (the probit

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unit equal to 50 per cent mortality) for Y and solving the regression equation for X.

Similarly, impact velocity values associated statistically with any per cent mortality may be calculated, as was done, for example, for 10 and 90 per cent mortality shown in Table VI comparing the results for the four species of animals employed. The table also presents the values for the regression equation intercepts and slope constants, the standard error of the slope constant and the 95 per cent confidence limits of the impact-velocity figures.

The solid lines in Figure 2 set forth a graphic comparison of data noted in Table VI. As far as the impact velocity figures associated with 50 per cent mortality are concerned, it can be said

curves for the mouse and rat were essentially parallel; so also were those for the guinea pig and the rabbit. Not so evident from visual inspection was the fact that the curves for the rat and guinea pig, and the rat and the rabbit could be regarded statistically as parallel. This is not the case for the mouse-rabbit and the mouse-guinea pig relationships which showed no parallelism statistically in the regression lines at the 95 per cent confidence limit.

Time of Death.—Two hundred animals were lethally injured by impact. The number of animals succumbing in various time intervals—0-5, 6-10, 11-20, 21-60, 61-120 minutes, and 121 minutes to 24 hours—is shown in Table

TABLE VII. TIME OF DEATH AND NUMBER OF ANIMALS MORTALLY WOUNDED BY IMPACT AND THE TOTAL INCIDENCE OF MORTALITY AS A FUNCTION OF TIME

| Species of Animal | Number of Animals Dying in Indicated Time Intervals | | | | | | Totals |
|-----------------------|---|----------|-----------|-----------|------------|-------------------|--------|
| | 0-5 min | 6-10 min | 11-20 min | 21-60 min | 61-120 min | 121 min to 24 hrs | |
| Mouse | 23 | 15 | 6 | 0 | 0 | 0 | 44 |
| Rat | 22 | 14 | 12 | 16 | 2 | 7 | 73* |
| Guinea pig | 30 | 6 | 6 | 9 | 1 | 5 | 57 |
| Rabbit | 4 | 4 | 7 | 5 | 2 | 4 | 26 |
| Total number | 79 | 39 | 31 | 30 | 5 | 16 | 200 |
| Total per cent | 39.5 | 19.5 | 15.5 | 15 | 2.5 | 8.0 | 100 |
| Accumulative number | 79 | 118 | 149 | 179 | 184 | 200 | |
| Accumulative per cent | 39.5 | 59 | 74.5 | 89.5 | 92.0 | 100 | |

*There were 17 rats not included in the total because time of death was not recorded.

that the LD_{50} value of 31.0 feet per second for the guinea pig was not significantly different from that for the rabbit of 31.7 feet per second. Those for the mouse (39.4 feet per second) and rat (43.5 feet per second), however, were statistically different from one another at the 95 per cent confidence limit; likewise, the LD_{50} 's for the guinea pig and rabbit were significantly below those for either the mouse or the rat at the 95 per cent confidence limit.

Concerning the variability in the slope constants, it may be stated that a test for parallelism using all the data indicated the results could not be fitted to a common slope with any statistical reliability. However, at the 95 per cent confidence limit, as might be expected from a visual inspection of Figure 2, the regression

VII, along with total percentage and accumulative percentage figures for the selected periods of time. Table VIII presents the percentage and accumulative percentage data for each species of animal.

The combined results given in Table VII show that death occurred quite rapidly; e.g., 149 of the animals, or 74.5 per cent, were dead within 20 minutes and 179, or 89.5 per cent, within one hour. Thus, only 21 of the 200 fatally injured animals lived longer than one hour and these—about 10 per cent of the total—died within twenty-four hours after impact, 5 between the first and second hour and 16 between the second and twenty-fourth hour.

The species-segregated data in Table VIII show other findings of interest. First, it is ap-

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parent that the mice died within an extraordinarily short period; i.e., 52, 86, and 100 per cent were dead within 5, 10, and 20 minutes, respectively. Second, mortally injured rabbits

animals mortally wounded, as given in Table VIII, as a function of time of death for each species separately. Because the number of animals surviving in the longer time periods was

TABLE VIII. PERCENTAGE AND ACCUMULATIVE PERCENTAGE OF LETHALLY WOUNDED ANIMALS AS A FUNCTION OF TIME AFTER IMPACT

| Time of Death | Percentage and Accumulative Percentage of Lethally Wounded Animals | | | | | | | |
|----------------|--|--------|----------|--------|-------------|--------|----------|--------|
| | Mice | | Rats | | Guinea Pigs | | Rabbits | |
| | Per Cent | Accum. | Per Cent | Accum. | Per Cent | Accum. | Per Cent | Accum. |
| 0-5 min | 52.3 | 52.3 | 30.1 | 30.1 | 52.6 | 52.6 | 15.4 | 15.4 |
| 6-10 min | 34.1 | 86.4 | 19.2 | 49.3 | 10.5 | 63.1 | 15.4 | 30.8 |
| 11-20 min | 13.6 | 100 | 16.4 | 65.7 | 10.5 | 73.6 | 26.9 | 57.7 |
| 21-60 min | | | 21.9 | 87.6 | 15.8 | 89.4 | 19.2 | 76.9 |
| 61-120 min | | | 2.8 | 90.4 | 1.9 | 91.3 | 7.7 | 84.6 |
| 121 min-24 hrs | | | 9.6 | 100 | 8.7 | 100 | 15.4 | 100 |

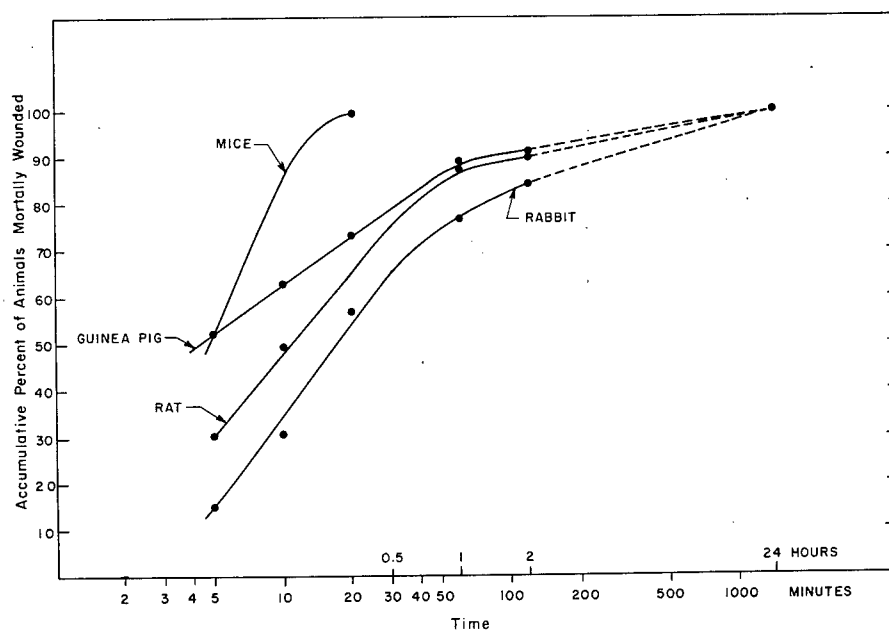


Fig. 3. Per cent of animals mortally wounded by impact as a function of survival time.

survived longer than the other species. Third, the times of death for guinea pigs and rats fell between those for mice and rabbits. Fourth, at the higher accumulative percentage of lethality—above 90 per cent for all species—there was a tendency for time of death to be related to animal size; i.e., the larger the animal the longer the survival period.

To emphasize these points Figure 3 was prepared and shows the accumulative per cent of

small and because of the wide variability among species, no detailed statistical assessment of the time of death data was undertaken. However, the early time to death is quite clear and impressive.

Interspecies Relationships and Extrapolation of Data.—Impact velocity and 50 per cent mortality.—The interspecies relationship between the impact velocity associated with 50 per cent

mortality in mice, rats, guinea pigs, and rabbits and the average weight of each species of animal was examined using the method of least squares. The results, plotted in Figure 4, show the LD_{50} impact velocity for each species as a function of mean body weight and the regression equation

using the method of least squares and a regression equation derived. The equation was:

$$\log S = 0.966 + 0.15358 \log \bar{M}$$

where

S = slope of the regression equation

\bar{M} = the average body weight in grams

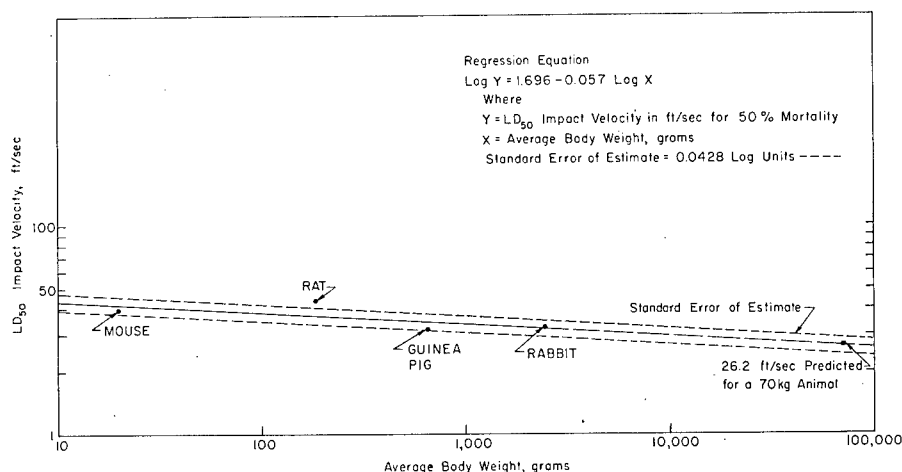


Fig. 4. Impact velocity associated with 50 per cent mortality as a function of average body weight.

which best fits the data; namely,

$$\log Y = 1.6961 - 0.0572 \log X$$

where

Y = impact velocity for 50 per cent mortality in ft/sec
 X = mean body weight in grams
the intercept = 1.6961 and
the slope constant = -0.0572

The standard error of the estimate was 0.042 log units (9.7 per cent).

This regression relationship may be used tentatively to predict the impact velocity associated with 50 per cent mortality for other species of animals. Solving the equation for an animal weighing 70 kilograms (154 pounds) yielded a figure of 26.2 feet per second (17.8 miles per hour) as the predicted LD_{50} impact velocity.

Slopes of the mortality curves:—It was of interest to explore the possible association between the average weights of the animals studied and the slopes of the probit regression equations describing the empirical relationship between impact velocity and mortality. This was done

The standard error of the estimate was 0.017 log units (3.89 per cent).

Solving this equation for an animal weighing 70 kilograms (154 pounds) yielded a predicted slope constant of 51.3. Graphic portrayal of the data relating the regression equation, slope constant, and average body weight for mice, rats, guinea pigs, and rabbits is presented in Figure 5 along with the regression line and the extrapolation to an animal weighing 70 kilograms.

Derivation of regression equation relating impact velocity and mortality for a 70 kilogram animal:—Having a predicted slope constant and a predicted LD_{50} impact velocity for a 70 kilogram animal made it a simple matter to substitute values in the regression equation of the form

$$Y = a + b \log X$$

and determine the intercept, a , of a predicted

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regression equation for the 70 kilogram animal;
e.g.,

$$S = a + 51.3 \log 26.2$$

$$a = S - 51.3 \log 26.2 = -67.758$$

some variation in the position of the animals when striking the concrete surface since the righting reflexes were employed to maintain a feet-down position. The second concerns a

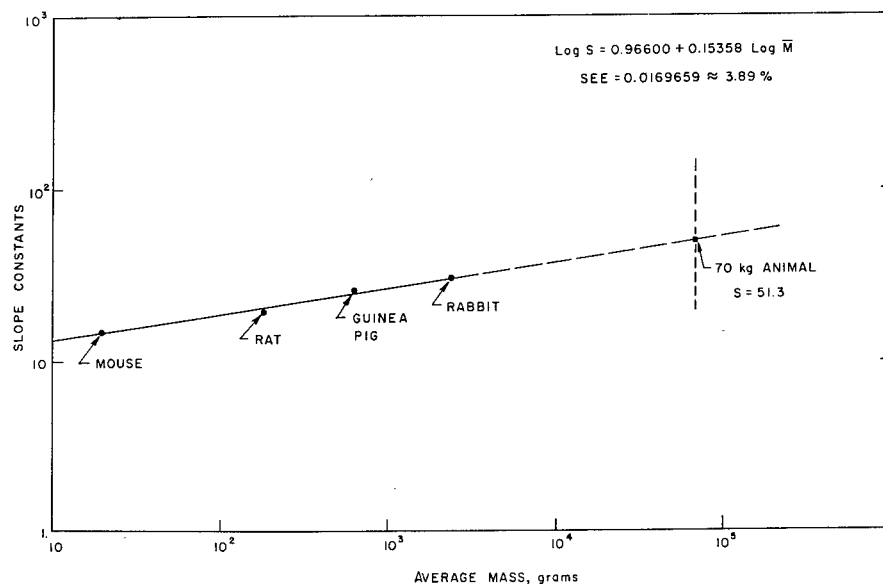


Fig. 5. Slope constants of the regression equations relating mortality and impact velocity as a function of animal weight.

Thus, it was possible to write for the 70 kilogram animal the following equation:

$$Y = -67.76 + 51.3 \log X$$

where

Y = per cent mortality in probit units

X = the impact velocity in ft/sec

The regression line for the above equation is shown dotted in on Figure 2 and allows one to visualize the predicted data along with the empirical findings for mice, rats, guinea pigs, and rabbits described previously.

DISCUSSION

General.—Strictly speaking, the data reported above apply only to young adult animals subjected to impact with a solid, flat surface in the prone position. Besides the innate biological variability mentioned years ago by Rushmer²⁵⁻²⁷ and Rushmer et al,²⁸ the experiments described here involve two other factors which might spuriously influence the relationship between mortality and impact velocity. The first concerns

possible modification of the impact velocity by whatever resistance the legs of the animals offered as energy absorbers to decrease the velocity of contact of the main mass of the body. Viewing the many movies taken of impact, however, revealed that in no observed instance was there much of a head- or tail-down position at impact; also, there was no appreciable slowing down of the animal detectable when velocities within the mortality range were reached.

Unfortunately, should a human be subjected to impact either involving falls, vehicular accidents, ground shock imparted to blast protective shelters or abrupt deceleration after displacement by blast winds, it is likely that considerable variation in the body area of impact will occur. Also, there are many circumstances in which a decelerative experience may involve glancing contact with an object; too, a great variation in the shape, weight and consistency of the decelerating object or surface may be involved. Any modification of the time of

deceleration and the distance over which it occurs will markedly influence the magnitude of the G load and the rate with which it develops. Such factors are responsible for human survival after falls described in the well known paper of DeHaven⁶ which concerned drop distances in three cases of 55, 93 and 145 feet, impact velocities ranging from about 60 to near 85 feet per second, and stopping distance of about 0.3 to 0.7 feet occurring in a time period in the vicinity of 0.01 to 0.02 seconds. Frequently, the surface struck is soft ground and the impact area of the body is large—the back, side or ventral surface—and these factors modify the relationships between impact velocity and biological effect.

Though refinements in terms of stopping distance and time as they influence G loading are important and have been well discussed by Rushmer et al,²⁸ DeHaven,⁷ Roth,²³ Haddon and McFarland,¹⁸ Stapp,²⁹ Goldman and von Gierke¹⁵ and others, there is nonetheless a problem in the human case—as noted in the Introduction—when impact with a flat, solid surface occurs and the stopping times and distances are controlled *only* by the tissues of the body itself. Ideally, one would like to know the relationship between impact velocity and mortality, the threshold for mortality and the threshold for tolerable trauma for the human case, all as functions of the different areas of the body that may come in violent contact with hard surfaces. Fortunately, there are a few relevant data on some aspects of this problem that are helpful, first, in setting quantitative relationships for man and second, in evaluating the extrapolations set forth in the present study. The more important of these now known to the authors will be briefly noted.

Literature Involving Human Material

Head:—Black et al,⁸ reviewing the records of British mine accidents in 1942, stated a skull fracture occurred from a probable fore-and-aft blow of 15 feet per second (equivalent to a 3½ foot drop) from a striking mass of about 8 pounds. Zuckerman and Black,³⁰ using monkeys strapped against a heavy plate set in sudden

motion by the impact of a heavy pendulum, failed to produce signs of concussion or fracture with “initial” velocities of 10 feet per second applied fore and aft.

Draeger et al⁹ ran two tests on an impact-shock test machine using cadavers lying face down and face up on the table at the time a maximum blow from a striking hammer produced an “initial” average velocity of near 15 feet per second. It was noted that no bone damage was produced for the face-up condition in contrast to the face-down instance wherein a linear fracture of the vault of the skull in the occipital region was found.

Gurdjian et al¹⁶ have pointed out that dry skulls have been fractured with energies as little as 25 foot pounds (300 inch pounds), but that cadaver heads with scalp and contents intact to “cushion” the blow required energies of close to 400 to more than 900 inch pounds to fracture. Important also is the fact that 10 to 20 per cent additional energy over that required to produce a single linear fracture almost completely demolished the skull, shattering it to fragments.

The same authors¹⁷ reported experiments from which the 400 to 900 inch pound figures were derived and pointed out the impact velocities involved when 46 intact human heads were dropped on a hard surface. These ranged from one instance with fracture at 13.5 feet per second to about 23 feet per second. The data grouped according to impact velocities are shown in Table IX.

While the skull varies in its strength, being minimal for midfrontal blows and maximal for the anterior interparietal positions, and energy at impact is the more precise means of assessing tolerance to abrupt deceleration, the tabulated distribution of impact velocities required for fracture has a great appeal for its simplicity. However, in assessing the data noted in Table IX, it must be realized that impact with a 90 degree sharp corner may require only 60 inch pounds of energy¹¹ for skull fracture and that an individual traveling horizontally and undergoing a head-on impact involves a situation different from the circumstances described above;

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e.g., the head then will have to absorb not only its own energy of motion, but also that of the following body as well; this places considerable strain on the neck and cervical spine.

near 13 feet per second allows one to feel fairly confident that an impact velocity with a hard, flat surface of 10 feet per second should prove to be an acceptable impact velocity for the head

TABLE IX. THE RANGE OF IMPACT VELOCITIES ASSOCIATED WITH EXPERIMENTAL SKULL FRACTURE OF THE SKULLS OF INTACT HUMAN HEADS
(After Gurdjian et al¹⁷)

| Range Impact Velocities ft/sec | Approx. Velocity in mph | Approx. Height of Fall ft | Number of Fractures | | |
|-----------------------------------|----------------------------|------------------------------|---------------------|-------------|--------------------------|
| | | | Of Heads | In Per Cent | Accumulative Per Cent |
| 13.5-14.9 | 9.5 | 37 | 9 | 19 | 19 |
| 15-16.9 | 10.9 | 48 | 10 | 22 | 41 |
| 17-18.9 | 12.2 | 61 | 12 | 26 | 67 |
| 19-20.9 | 13.6 | 75 | 13 | 24 | 91 |
| 21-22.9 | 15.0 | 91 | 4 | 9 | 100 |
| Totals | | | 46 | 100 | |

Minimum velocity with fracture—13.5 ft/sec (9.2 mph)
Maximum velocity with fracture—22.8 ft/sec (15.5 mph)
Maximum and minimum velocity without fracture—unstated

The careful reader will realize that nothing yet has been said about cerebral concussion. Indeed, it is true that concussion may well be a more dangerous lesion than skull fracture; too, it can occur in the absence of fracture of the cranial vault. It is unfortunate that no significant amount of quantitative human data are available for concussion,¹⁸ though Lissner and Evans²⁰ have stated that if the energy to be dissipated by impact loading of the skull is kept below 400 inch pounds (33 foot pounds), they feel neither severe concussion nor fracture will result. In terms of a 10 pound mass, near the average weight of the adult human head, this is equivalent to a drop from a height of 40 inches and an impact velocity of 14.7 feet per second. This figure is well above the British experience of Zuckerman and Black³⁹ with monkeys, quoted above, noting that 10 feet per second produced no signs of concussion or fracture.

Last, with regard to the head problem, no data are at hand for infants, children and adolescents at one end of the age scale nor those in the last decades of life at the other, as pointed out by Haddon and McFarland¹⁸ in a competent general review of the present knowledge concerning head injury. However, for adults the consistency between the British and American data placing the threshold for skull fractures at

of adult man which opinion is compatible with findings attributed to Lombard;²³ namely, that helmeted subjects voluntarily tolerated blows to the helmet, involving velocities from about 11 to 14 feet per second. Such blows involved an acceleration distance of near 0.1 foot, force application time close to 17 milliseconds and a maximum G load of from 15 to 35 G.

Lower extremity:—Casualty experience during the second World War included many instances of the very serious fracture of the calcaneus (heel bone), other bones of the foot, legs, spine, and skull which were caused by explosions of bombs, mines, or torpedoes below the decks of or near vessels.^{1,10} Such observations stimulated laboratory investigations on the lower extremity of intact cadavers.

In Great Britain, Black, Christopherson, and Zuckerman³ reported experiments in 1942 using two embalmed cadavers. With the knees locked and with the bottoms of the feet made parallel to the floor, using wooden blocks, one of the cadavers was dropped to the deck from heights of 0.5, 1.0, 2.0, and 4.0 feet. Only the latter drop produced boney pathology—a complete fracture of the heel bones bilaterally with a “chip fracture” in the posterior surface of each. The impact velocities at 2 and 4 feet were about 11

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and 16 feet per second, respectively, and the authors concluded that an initial velocity within these limits might well mark the fracture threshold for barefooted individuals.

The second cadaver was fitted with "specially devised boots which had sponge-rubber pads on the inside of strong rubber heels." After a drop of 3 feet (near 13.9 feet per second impact velocity) fracture of the left talus bone was noted (the talus lies above the calcaneus, or heel bone, and separates the latter from the two bones of the lower leg at the ankle). After drops from 6 feet (19.6 feet per second) additional fractures were noted; e.g., inner margins of the lower end of the left tibia; the outer and inner condyle of the upper end of the left tibia, and the whole upper end of the right tibia.

In 1945 Draeger et al⁹ described experiments with four embalmed cadavers and human volunteers using a high impact test machine, the 4000-pound table of which was energized by an upward blow of a 3000 pound hammer allowed to swing in an arc from different heights. Fractures were produced in two of the cadavers under circumstances for one covered by high speed photography. The impact velocities withstood by human volunteers was not stated.

The photographic records revealed the data noted in Table X showing the movement of the table on which the cadaver was standing with knees locked and the average velocities of the table and a metal bar piercing the tibia just above the ankle of the subject, both given as a function of time. Fractures of the os calcis (calcaneus) occurred and the reader will note that over the first 5 milliseconds the velocity figures given in the next to last column of Table X, obtained by step-by-step calculations for table movement, ranged from 12.9 to 21.4 feet per second. These numbers are reasonably close to the British figures which placed the "initial velocity" threshold for fracture of the heel bone between 11 and 16 feet per second.

Though there is much food for thought in the work of Draeger et al, in the interest of simplicity it is well to emphasize that impact velocities much above 11 to 12 feet per second can cause fracture. In relation to these data for

fractures, it is appropriate now to direct attention to recent work with human volunteers which goes to the point of voluntary tolerance to vertical loads applied to the feet of standing human volunteers.

TABLE X. IMPACT TABLE MOVEMENT AT DIFFERENT TIMES AND THE AVERAGE VELOCITIES OF THE TABLE TOP AND THE TIBIA OF A CADAVER EXPOSED STANDING WITH KNEES LOCKED (After Draeger et al⁹)

| Displacement of Table Inches | Time in msec | Average Velocity in ft/sec | |
|------------------------------|--------------|----------------------------|-------|
| | | Table Top | Tibia |
| 0 -0.25 | 0 -1.62 | 12.9 | 9.8 |
| 0.25-0.60 | 1.62-3.25 | 16.9 | 10.1 |
| 0.60-1.50 | 3.25-5.0 | 21.4 | 16.2 |
| 1.05-1.09 | 5.0-6.5 | 2.2 | -5.0 |
| 1.09-1.33 | 6.5-8.2 | 11.8 | 9.8 |
| 1.33-1.73 | 8.2-10.0 | 18.5 | 18.1 |
| 0 -2.48* | 0 -15* | 13.7* | 10.2* |

*Data read from smoothed curve

Swearingen et al³⁰ have reported nearly 500 experiments with thirteen adults subjected to drop tests in a track-guided chair travelling vertically downward to impact against a platform. The movement of the latter was damped with heavy leaf springs and hydraulic pistons. Though the base platform was capable of a maximal movement of 1 inch, the actual movement at impact was known to be small, but not stated. However, G-time recordings were made when standing individuals with knees locked were subjected to drops from a maximal height of 2 feet.* The theoretical impact velocity connected with this fall height is 11.3 feet per second. Integration of the G-time curve recorded and reported—which showed a maximum G of 65 developing at 10,000 G per second with impact enduring for 8 milliseconds—gave a calculated impact velocity of 9.9 feet per second. This figure is within about 12 per cent of the theoretical figure.

The loading associated with about 10 feet per second impact velocity was the maximal tolerated by the human subjects. Severe pain was noted in the chest, epigastrium, lower back,

*Swearingen, J. J.: Personal communication.

hip joints, and top of the head. Also, pain was reported in the arches of the feet, back of the legs, ankles, heels, and throat.

Spine:—In similar experiments with seated subjects, Swearingen and co-workers³⁰ determined the limit of voluntary tolerance to be associated with a maximal load of 95 G developing at 19,000 G per second over a time period of 7.5 milliseconds; the impact velocity calculated from the G-time curves was 9.7 feet per second. Severe pain in the chest, spine, head, and stomach was noted and "shock: severe, general" was reported.

There is little point in reviewing the many ejection seat data considered safe and unsafe by various investigators. Let it suffice to say that they are not inconsistent with the findings of Swearingen et al, that Ruff²⁴ estimated fractures of the spine could occur at about 100 G when the time involved was as short as 2 milliseconds, and that Gagge and Shaw¹⁴ have stated application of 20 G developing at the rate of 150 G per second and enduring for 200 milliseconds was acceptable for pilots using ejection seats for escape from aircraft, and that Watts et al³³ reported 20 G for 0.08 second applied at the rate of 200 G per second produced no symptoms in 50 volunteer naval subjects.

Automobile accidents:—Finally, it is of considerable interest to note National Safety Council statistics quoted by DeHaven⁷ relevant to fatalities in urban automobile accidents. The figures show that "40 per cent of automobile fatalities in urban areas involved a speed of 20 miles per hour or less and 70 per cent were attributed to accidents in which the speed did not exceed 30 miles per hour." This would place the 50 per cent mortality figure near 23 miles per hour (33.8 feet per second). It is necessary to point out, however, that this velocity apparently refers to the speed at which a crash occurred and may or may not refer to actual velocity at which a fatally injured person struck a solid surface.

Present Study

General:—Obviously, what has been as-

sembled from the literature both for the human and the animal case, along with the present interspecies study, indicates that the "state of the art" for understanding the biology of decelerative impact is not very far advanced. Much more quantitative information is needed to establish tolerance for various organs and regions of the body, particularly in the case of the friable liver and spleen and the other abdominal organs. Likewise, additional data are desired for the thorax and its organs, for the head and its contents, and for the cervical spine. Be this as it may, a few comments are in order concerning the experiments reported here and their relation to the literature reviewed. These will now be presented.

Extrapolation of the LD₅₀ impact velocity data:—Though it is hardly possible to imagine what precise use might be made of the described interspecies extrapolation of the LD₅₀ impact velocity to give a figure of 26 feet per second (18 miles per hour) for the 70 kilogram animal, it is nonetheless quite interesting that the data for human fatalities in automobile statistics⁷ show a 50 per cent mortality at vehicular speeds near 33.8 feet per second (23 miles per hour). Thus, the animal extrapolation of the 50 per cent impact velocity is 22.5 per cent lower than the vehicular speeds associated with 50 per cent fatalities. While this apparent correspondence may be more fortuitous than real and a number of grave uncertainties are no doubt involved, it could also represent more than an accidental array of factors. At least, the situation is sufficiently encouraging to suggest a number of worthwhile contingencies. First, additional and somewhat similar animal studies are justified; second, all efforts to collect relevant data referable to the human case from past experience and in the future are indicated; third, the extrapolation to the 70 kilogram animal can be tentatively regarded as applying "on the average" to man (a) for the purposes of testing such a hypothesis, and (b) for use under certain circumstances because nothing better seems to be at hand.

The regression equation for the 70 kilogram

animal and the threshold for mortality and injury concept.—The regression equation for the 70 kilogram animal—arrived at by extrapolation and predicting the relationship between impact

TABLE XI. PREDICTED IMPACT VELOCITY AT THRESHOLD OF MORTALITY

| Animal Species | Predicted Impact Velocity at Mortality Threshold | |
|----------------|--|------|
| | ft/sec | mph |
| Mouse | 18.2 | 12.8 |
| Rat | 24.0 | 16.8 |
| Guinea pig | 19.9 | 13.5 |
| Rabbit | 21.8 | 14.8 |
| 70 kg animal | 20.8 | 14.1 |

velocity and mortality—is of interest, for with its use one can explore the mortality threshold situation for the 70 kilogram animal as well as for the four species empirically studied. Assigning zero to Y in the probit regression equations and solving them for X, yields figures for impact velocities predicted to be near the threshold for mortality. Doing this simple calculation gave the figures set forth in Table XI.

Two things are significant about the tabulated data in Table XI. First, there is very little difference in the threshold impact velocities for all species and for the 70 kilogram animal, suggesting there may be a common mechanism that is critical for mortality. Second, the impact-velocity numbers are higher than those known to be associated with quite dangerous, perhaps fatal, lesions in man, such as the range in impact velocities for human skull fracture from 13.5 to 23 feet per second (9.2-15.6 miles per hour) reported by Gurdjian et al.¹⁷ Third, the predicted impact velocities for the threshold of mortality are well above the impact velocity of about 10 feet per second voluntarily tolerated by standing and seated human subjects studied by Swearingen.³⁰ Fourth, the general consistency of the information just noted above suggests one can tentatively take 10 feet per second as an "on-the-average safe" impact velocity for adult humans and regard the probabilities of serious injury and even fatality for man to increase progressively as the impact velocity is elevated above this figure.

Time of death.—It is well to re-emphasize again the short time to death observed in the 200 untreated animals dying of impact in relation to the high mortality figures associated with vehicular accidents which reoccur on an annual basis. How many of the animals dying in the present study could have been saved by therapeutic measures is, of course, not known, but there are many human accident victims alive today because medical care was appropriate both in kind and in time. The rapidity with which the experimental animals expired makes it impossible to resist suggesting that one possible way to reduce fatalities in vehicular accidents would be to explore and implement all arrangements that would assure the earliest possible medical care.

Cause of death.—Finally, the inquisitive reader can well ponder along with the authors the several possible pathophysiological mechanisms responsible for death of the animals studied. Currently, it is not possible to present relevant data; neither may it be possible to do so in the future. However, gross pathological observations were made on the animals who died spontaneously and who were sacrificed after impact. It remains for further studies to reveal whether the gross data are adequate or inadequate to the challenge of throwing more light on the etiology of death by violent impact.

SUMMARY

1. A total of 455 animals including 113 mice, 178 rats, 111 guinea pigs and 54 rabbits were subjected to impact at velocities ranging between 25 feet per second and 51 feet per second.
2. The desired impact velocities were generated by allowing the animals to free-fall from various heights to a flat concrete pad. The ventral surface of each animal was the area of impact.
3. The velocities at impact were determined from equations that were empirically derived and from high speed photographic records of the animals.
4. Probit analyses of the 24-hour mortality data yielded LD₅₀ values with 95 per cent con-

fidence limits as follows: mouse, 39.4 feet per second (37.4-42.0); rat, 43.5 feet per second (42.0-44.8); guinea pig, 31.0 feet per second (30.0-31.9); and rabbit, 31.7 feet per second (30.2-33.3).

5. Of the 200 animals killed by impact, 149 (75 per cent) died within 20 minutes and 90 per cent within one hour. Only 10 per cent of the deaths occurred between the 2-hour and 24-hour period. The general trend was for the larger species to have the longer survival times.

6. From an interspecies extrapolation the LD₅₀ impact velocity for a 70 kilogram animal was calculated to be 26 feet per second (18 miles per hour).

7. From the probit mortality curve derived for a 70 kilogram animal, the predicted threshold condition for lethality was calculated to be 21 feet per second (14 miles per hour).

8. The results from the present study were discussed relevant to the information available in the literature on the effects of ground shock on personnel in underground structures, deck heave, translation caused by air blast, automobile accidents, falls, and related decelerative phenomena.

9. The minimum impact velocity required for skull fracture was pointed out to be near 13.5 feet per second (9.2 miles per hour). (Gurdjian et al).

10. The "initial velocity" threshold for fracture of the heel bone of standing objects was between 11 and 16 feet per second (Black et al; Draeger et al).

11. The maximal impact velocity tolerated by human subjects, dropped in a seated position, was reported to be about 10 feet per second (Swearingen et al).

12. Human fatalities in automobile statistics showed 50 per cent mortality at vehicular speeds near 33.8 feet per second (23 miles per hour) which was in fair agreement with the 50 per cent impact velocity (26 feet per second) obtained in the present study for an animal of comparable body weight (from DeHaven).

13. It was tentatively concluded that 10 feet

per second (7 miles per hour) was the "on-the-average safe" impact for adult humans.

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Primary Pigmentary Degeneration of the Retina

A Case Report

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P RIMARY PIGMENTARY degeneration of the retina is a rare, hereditary, progressive disorder of the eye which frequently produces blindness early in life. It occurs in three genetic forms—dominant, recessive, and sex-linked recessive—and may be due to the substitution of four different genes. The dominant type tends to be less severe, occurring later in life and with much slower progression, so that incapacitating blindness is rare in this group. Night blindness is a universal symptom and frequently occurs in the first few months of life. Progressive blindness then follows with varying speed. Most patients with the recessive types are blind by age thirty, and those with the dominant type have difficulty with vision and classical ring scotomata by age fifty. Except for five reported unilateral cases, the disease is bilateral. Other hereditary defects are frequent, including posterior subcapsular cataracts, otosclerosis, polydactylism, obesity, hypogonadism, and mental deficiency.

CASE PRESENTATION

The present case concerns a senior Air Force officer, aged 49, with 5000 hours military flying time. He is jet-qualified and a command pilot. He has noted poor night vision for many years and recently complained about some decrease in visual acuity in his left eye and a diminished field of vision. Examination by his local flight surgeon demonstrated evidence of retinitis pigmentosa, and he was referred to the School of Aviation Medicine for consultation. He denies any ocular discomfort or limitation in daytime vision. Family history revealed that his mother and two of her brothers suffered from visual loss in the seventh and eighth decades of life due to degeneration of the retina.

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Ophthalmological Examination.—Examination of his eyes revealed no gross abnormalities, normal muscle balance, and normal pupillary responses. On ophthalmoscopic examination the media were clear and the discs were normal. A generalized mild constriction of the arterioles was observed with many areas of pigmentation (much of it in the characteristic "bone corpuscle" configuration) throughout the mid-periphery. Several of the vessels were "wrapped" with pigment, and the entire process appeared to be more advanced in the lower fundi. The fovea of the right eye was normal, but there was slight mottling and depigmentation in the left macular region. Distant visual acuity was 20/25, correctible to 20/15 by -0.50 S $+0.25$ Cx 90 degrees, in the right eye and 20/50, correctible to 20/25 by -0.75 S, in the left eye. Near vision was correctible to 20/20 OD and 20/25 OS with $+2.00$ add to each of the above prescriptions.

The visual fields (Fig. 1) revealed a nearly complete ring scotoma in each eye. This scotoma breaks through to the periphery in the right eye. The tangent screen examination revealed marked reduction in the area of visibility for both the one and five millimeter test objects. Slit lamp examination was not remarkable except for loss of luster of the posterior capsules of both lenses. Studies with the Goldman-Weekers adaptometer revealed a very flat dark adaptation curve with only a small "break" occurring at thirteen minutes, indicating a severe loss of rod function. The patient failed the radium plaque Landolt "C" Night Vision Test, as he was unable to discern the break in the circle at any distance.

The remainder of the physical examination was non-contributory. Laboratory studies including a serologic test for syphilis were within normal limits.

DISCUSSION

This patient demonstrates nearly all of the classical findings in retinitis pigmentosa. The visual fields, ophthalmoscopic picture, loss of night vision, and posterior capsular changes are typical and diagnostic. The deficit in the visual fields is more pronounced in the upper portion

DEGENERATION OF THE RETINA—MOORE AND CULVER

corresponding to the greater density of the pigmentary lesion in the lower fundus. The posterior capsular changes may well be the beginning of a posterior subcapsular cataract which

The probable presence of the disease in his mother and two of her brothers supports this view. The dominant form is much more likely to occur each generation, and most cases are

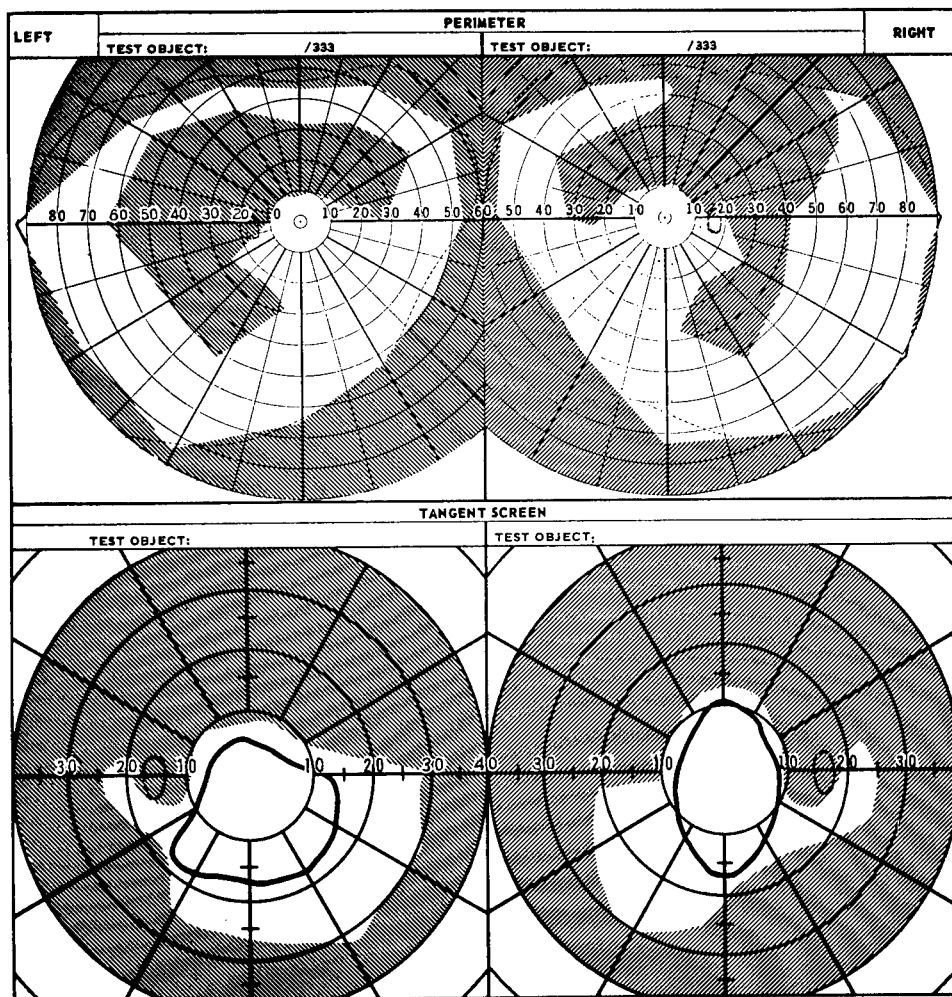


Fig. 1. The perimeter studies were done at 333 mm. with a 3 mm. white test object. The shaded area in the tangent screen charts demonstrated the area of visual loss with a 5 mm. white test object at 1 meter; the solid line demonstrates the limits of visualization of a 1 mm. white test object at 1 meter.

is frequently associated with retinitis pigmentosa.

The unusual aspects of this case are its appearance so late in life and the lack of symptoms. For this reason, it must be concluded that this represents the dominant hereditary pattern.

mild and occur in the fourth and fifth decades. The disease is probably less severe in the dominant form because only one gene is involved, the other one of the pair being normal. On the other hand, in the recessive forms of the disease both genes must be defective, and a

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more severe defect would be expected. Although this patient will have progressively less vision, eventual blindness is very unlikely.

AVIATION MEDICINE IMPLICATIONS

From the aviation medicine viewpoint, the amount of visual deficit must be properly assessed in this case. Although the loss of night vision is not incapacitating, it would be of significance in most military and civilian flying. When the visual fields are projected upon one another, it is readily seen that a large portion of the superior visual field is obliterated in binocular vision. This extends across the horizontal meridian on the left covering the area from 15 to 25 degrees. Although it cannot be said from perimetry that there is no perception in this area, vision is markedly reduced; and the subject is not likely to perceive objects in the area subtended by this defect. At 500 feet he will have a blind spot (with binocular vision) 87 feet wide in the horizontal meridian—a space twice the wing span of T-33 aircraft and large enough to include most aircraft. The patient has undoubtedly compensated for this large scotoma by scanning and thus has very minor symptoms. This visual defect, which would not interfere with most activities, constitutes a serious disability in flight and during aircraft ground operations.

No treatment is available which will affect the

course of the disease. Vitamin A, pituitary extracts, placental transplants, and liver extract have been tried in the past with inconsistent results. The process is the result of a defective gene, but the pathogenesis of the retinal degeneration is poorly understood. Many individuals have proposed eugenic measures to eradicate the disease, and consanguineous unions between persons with the recessive type (the more common and severe form) should be discouraged. The dominant form is so mild that eugenic measures are not indicated.

SUMMARY

A case of primary pigmentary degeneration of the retina in a USAF command pilot is presented. The pattern and pathogenesis is discussed briefly. Aeromedical implications of this case are presented.

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Hepatitis and Dentistry

Unsterile dental instruments, contaminated with only minute amounts of diseased blood, may transmit viral hepatitis, according to a report by Dr. Holmes T. Knighton in the *Journal of the American Dental Association*.

Although needles and syringes are the most

likely means of transferring contaminated blood from one person to another, scalpels, forceps, periodontal instruments and others that are used to penetrate tissues are always potential carriers of the viruses in the blood or blood products unless they are sterilized.—From *MD*, 1961.

Spontaneous, Recurrent Left Bundle Branch Block Without Apparent Heart Disease

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BUNDLE BRANCH BLOCK is not rare and, once established, it tends to remain permanent since most cases have an organic basis, especially those cases with left bundle branch block (LBBB). A diligent search of the literature revealed cases with the feature either of recurrency or of absence of apparent heart disease. Spontaneous, recurrent LBBB without apparent heart disease in an individual followed for more than twenty years has not been reported.

In 1933 Carr² reported a case of BBB which could be terminated by vagal stimulation. Five months later the BBB was still present but could not be abolished by a vagal response. In the same year Sigler⁸ reported the termination of BBB by vagal stimulation in a patient without apparent heart disease and suggested fatigue as the cause. More recently, Eichert³ reported a case in which the BBB occurred whenever the cardiac rate was increased sufficiently. No evidence of organic heart disease could be demonstrated. In 1956 Berquist and Hallen¹ described two cases in middle-aged men without evidence of cardiac disease but with cardio-neurotic symptoms. In both, the block could be induced or abolished by various maneuvers which increased or decreased the heart rate. In one patient, the BBB was found during two periods a year apart, but in the interval, the block could not be induced despite a heart rate much higher than that required to cause it in the earlier and later periods. Two similar cases were reported by Vesell¹⁰ of organic heart dis-

ease with unstable BBB which was related to slight changes in the heart rate. Willius and Anderson¹¹ observed a sixty-three-year-old man for four months during which time the BBB, due to arteriosclerosis, occurred and disappeared from day to day.

CASE REPORT

The patient is a pilot, aged fifty, at present Regional Manager of Flight for American Airlines. Up to April 1953 when the first abnormal electrocardiogram was found, he worked as a regular line pilot for the same company and had been so employed since 1937. At no time has he complained of any symptoms. Annual physical examinations from 1937 have never revealed any abnormalities. Yearly electrocardiograms from 1941 to 1953 were normal. The examination in April 1953, at age forty-two years, revealed a blood pressure 120/72 and heart rate 78 with a regular sinus rhythm. The heart sounds were of good quality and no murmurs were heard. Chest x-ray showed the heart to be normal in size and contour. The electrocardiogram revealed a left BBB.

In May, 1953, he was evaluated at the Lovelace Clinic where the Master two-step test was positive and the ballistocardiogram showed a grade 1 abnormality. No other positive findings were elicited. He was permitted to fly only as a check pilot for a period of sixty days. In July 1953, he returned to the Lovelace Clinic, and again the Master two-step test was positive. The Clinic diagnosis was coronary artery disease with some coronary insufficiency. The patient was completely free of symptoms. In September 1953, he was not permitted to fly the line as captain.

He continued to enjoy good health, free from any symptoms. After three normal electrocardiograms in October and November 1954 he was returned to full flying duties. Five years later, in May 1959, the routine annual electrocardiogram again revealed LBBB. Remainder of the examination was normal. The patient was re-evaluated at the Lovelace Clinic in June 1959. At this time, the Master two-step test was negative and the ballistocardiogram was normal;

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Presented at the Acropsace Medical Association meetings, April 26, 1961, in Chicago, Illinois.

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after smoking the ballistocardiogram showed a grade 1 abnormality. The blood cholesterol was 215 mg. per cent. He was advised to discontinue smoking, which he did. During 1959 and 1960 six electrocardiograms obtained in different months revealed LBBB, but he

TABLE I. ECG'S BY DATES

| Normal | Left BBB | Abnormal T Waves No BBB |
|---|--|----------------------------|
| From Sept. 1941 thru Apr. 1952 7 normal tracings | | |
| Oct. '53 | Apr. '53 June '53 | |
| Mar. '54 | Dec. '53 May '54 | |
| Oct. '54 | | |
| Nov. '54 (2) | | |
| June '55 | | |
| Jan. '56 | | |
| Jan. '57 | | |
| Feb. '58 | May '59 Dec. '59 Jan. '60 Apr. '60 June '60 July 18 '60 | |
| Sept. '60 | | July 22 '60 July 25 '60 |

The period covered by the electrocardiograms is twenty years. From September 1941 through April 1952 seven tracings were normal. In April 1953, at the age of forty-two years, the first abnormal tracing showing a LBBB was obtained. During 1953 and 1954, four tracings revealed LBBB in different months. From May 1954 to May 1959, seven electrocardiograms were again normal. In 1959 and 1960, six separate tracings reverted to LBBB. On July 22 and 25, 1960, several days after the last electrocardiogram with LBBB, two tracings revealed the absence of LBBB, but the T waves in V_1 through V_4 were inverted. Two months later, in September 1960, the tracing was completely normal again.

DISCUSSION

Although the preponderant opinion in the literature states that BBB is a manifestation of advanced cardiovascular disease, exceptions do occur. The pattern of BBB can be present because of many factors. A localized permanent lesion in a bundle need not be invoked as the only explanation of BBB. Other conditions such

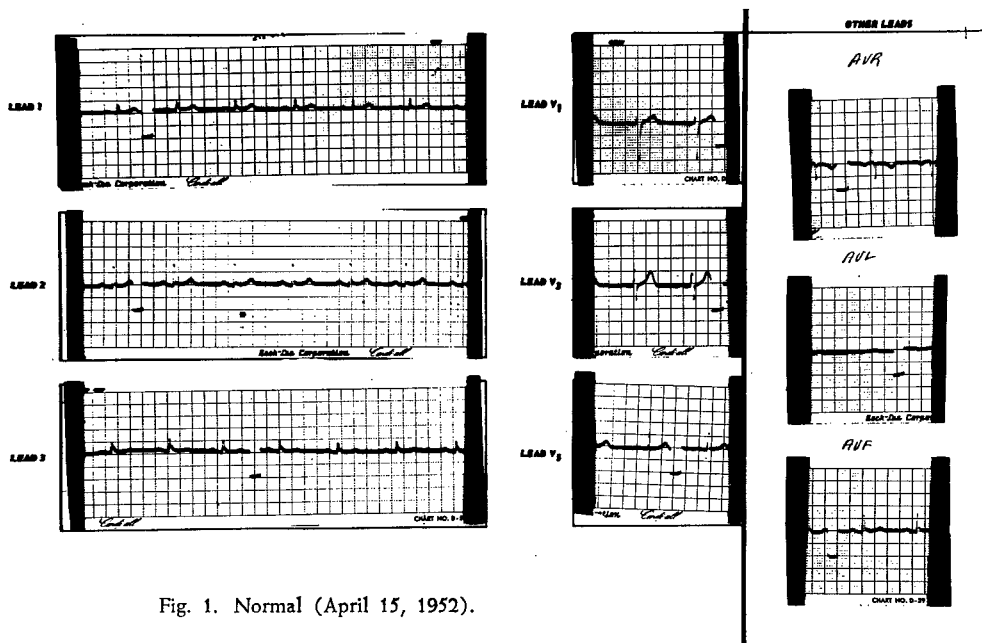


Fig. 1. Normal (April 15, 1952).

had no complaints whatsoever. A tracing obtained in September 1960 was again normal and he has continued to fly as captain. The last electrocardiogram in April 1961 had reverted once again to LBBB.

Description of Electrocardiograms (Table I).—

as tachycardia, pulmonary embolism, vagal effects, anoxia, anemia and metabolic disorders, especially when superimposed on already existing heart disease, may hamper conduction in a bundle. The elimination of these factors may

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cause the disappearance of the conduction defect. Intermittent LBBB may occur after myocardial infarction, during congestive heart failure and acute infections, as a result of drugs such as quinidine, and during cardiac cath-

terization. While these are the common organic causes, the list is not complete. Evidence of organic etiology was not manifest in our case.

The benign aspects of BBB were presented

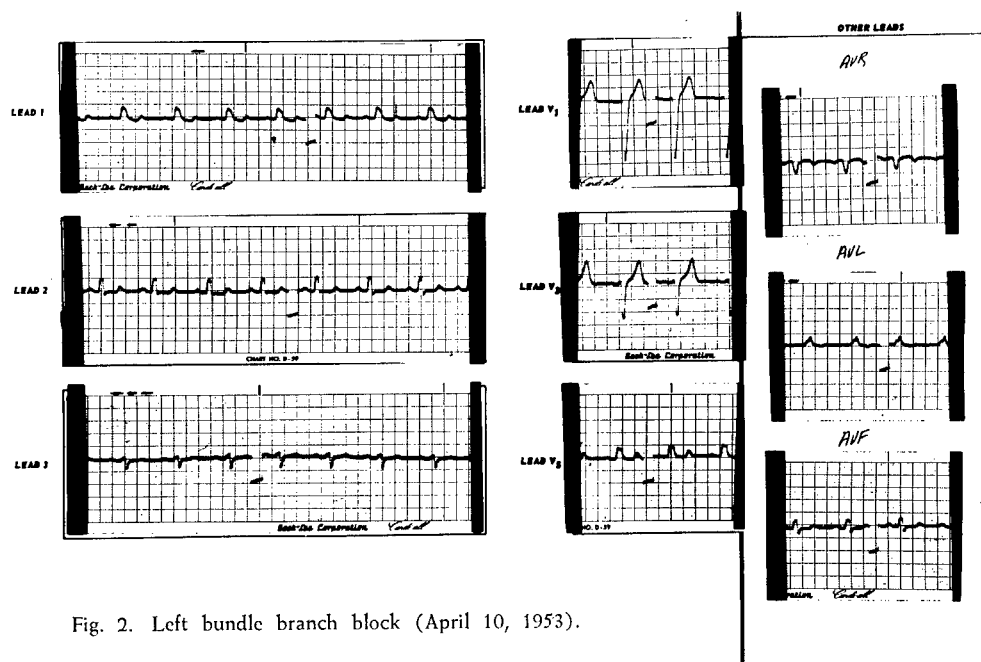


Fig. 2. Left bundle branch block (April 10, 1953).

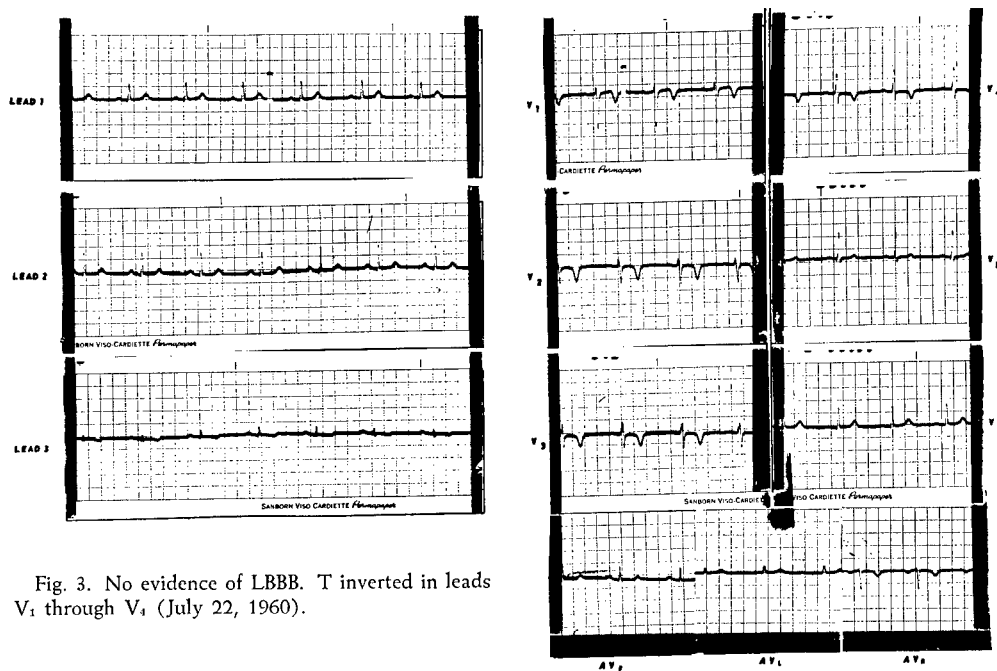
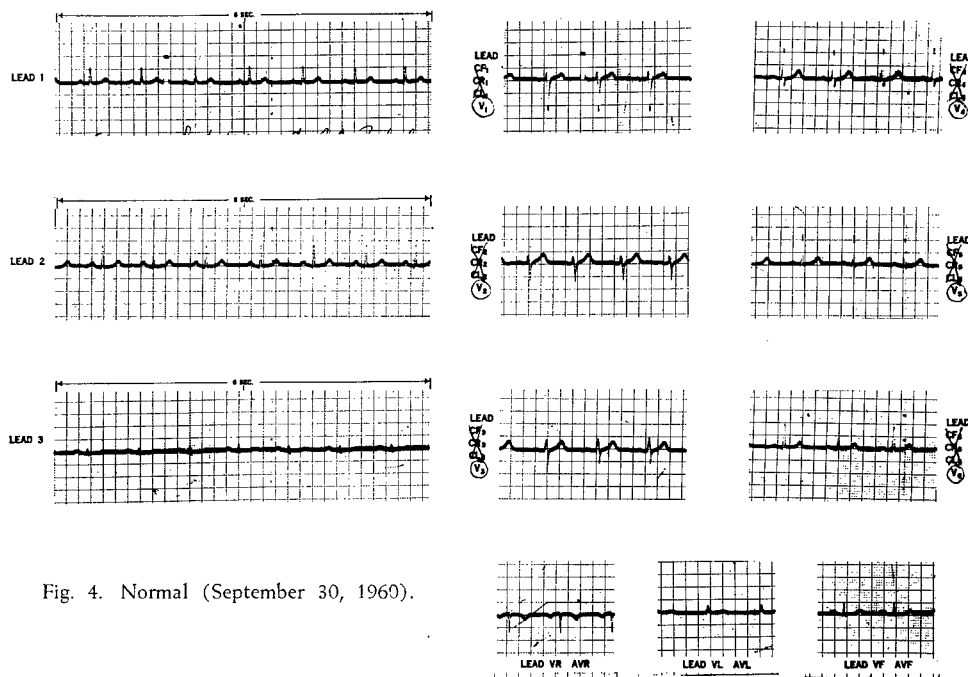


Fig. 3. No evidence of LBBB. T inverted in leads V₁ through V₄ (July 22, 1960).

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by Vazifdar and Levine⁹ who followed a group of thirty-one patients with permanent BBB for five to twenty-nine years. These persons remained well and had no other subjective or ob-

jectivize the heart or its two bundles being so selective. A difference in the histologic structure of the conductive tissue of the right and left bundle has not been demonstrated. While



jective evidence of heart disease. In a series of 5000 electrocardiograms, Wolfram¹² reported fifty-two cases of BBB of which thirty-three had no clinically evident cardiac disease. Of sixty-four patients with right BBB studied by Wood, Jeffers and Wolferth,¹³ twenty-five had no evidence of organic heart disease. It would be difficult to ascribe an organic etiology to the case reported by Graybiel⁴ et al, of a twenty-four-year-old aviator who developed BBB as a result of a fright stimulus produced by the firing of a pistol close to him; the block persisted for two days. It is cases such as this one that point to the probability that all defects of intraventricular conduction are not due to anatomic change.

Lamb, Kable, and Averill⁵ recently stated that it is generally accepted that RBBB may occur as a congenital finding or exist without cardiac pathology, but that it is doubtful if the same can be said regarding LBBB. It is difficult to vis-

ualize the heart or its two bundles being so selective. A difference in the frequency of involvement between the two bundles seems not unlikely, the various etiologic factors, organic or functional, would not be expected to exert a selective action exclusively on one bundle and never on the other. In other words, why should only RBBB occur without cardiac pathology?

There is no question that BBB is associated with a decreased life expectancy in patients who have organic heart disease, and LBBB carries a poorer prognosis than RBBB. Disagreement arises as to etiology, whether organic or not, in a small percentage of cases especially the transient or intermittent type. In the case presented some may consider the positive Master two-step test and the grade 1 ballistocardiogram abnormality evidence of organic heart disease. If so, how does one explain the negative Master test and the normal ballistocardiogram six years later when there was a spontaneous recurrence of the LBBB. Temporary negative T waves can

occur after exercise in young healthy males with no evidence of heart disease.

The etiology in the case presented is not clear. Organic causes have not been evident and usually produce a permanent block, although one of Sandberg's⁷ cases with organic heart disease and LBBB developed normal conduction after five years. A congenital basis can be readily eliminated in view of the many normal electrocardiograms. Rheumatic fever and the various infections can be ruled out by the history and the changing electrocardiograms. In this connection it is of interest that in one report of LBBB,⁸ a previous rheumatic myocarditis was presumed as the etiology because of a history of scarlet fever in childhood. Unless the evidence indicates or strongly suggests a myocarditis at the time of the acute infection, one is not justified in attributing the etiology to scarlet fever. A clear-cut history of rheumatic fever with myocarditis would be strongly suggestive but not conclusive and, of course, would cause a changing electrocardiogram only in the acute phase.

One report⁶ warns that in approaching the clinical significance of intermittent BBB, one must avoid the pitfalls that have plagued similar analysis of permanent BBB. A mere long-term follow-up of patients with a given finding does not prove the absence of underlying cardiac malfunction. The analogy with cases of myocardial infarction is not well chosen since it is doubtful if anyone intended to give the impression that myocardial infarction is "benign" because a patient lived ten to twenty years after it. In the case of infarct, organic disease is present at the outset whereas, in the other, organic disease must be demonstrated. There is no doubt that LBBB secondary to coronary artery disease cannot be considered "benign." However, the intermittent and spontaneous, recurrent types may be the exception especially if repeated study reveals no apparent heart disease.

It is difficult to assign an organic etiology to our case. The spontaneous, reversible electrocardiogram changes during a period of eight years without alteration in the normal clinical

picture make it unlikely that arteriosclerosis, myocarditis, active or inactive, or other organic myocardial change is the etiology. If such is the case, it is a most unusual manifestation of myocardial damage. To postulate various possibilities is not pertinent to this report and would add nothing. It is important to recognize the occurrence of transient LBBB and to evaluate each case strictly on its own merits. Even though the large majority have an organic basis, the evidence in this and other reports supports the conclusion that all cases of LBBB are not due to organic change. The need for a hard, second look at the clinical significance of LBBB is indeed clearly indicated.

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Weight Control—A New Air Force Program

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THE POSITION the United States Air Force has taken concerning overweight is stated in its medical examination manual, "Medical evidence indicates that overweight is an important factor in degenerative disease processes."¹ Actuarial studies have fully justified the Air Force stand that significant overweight is associated with excessive mortality.^{2,3}

Sudden disability attributed to overweight is believed to have caused severe in-flight emergencies and failure to complete air missions. It is axiomatic that men flying in high-speed, high-performance aircraft must be in top condition.

This paper presents an exposition of current Air Force weight standards, a proposal for their modification, illustrative data on their maintenance, and a comment on the importance of their enforcement.

TRADITIONAL STANDARDS:

WEIGHT INCREASE WITH AGE

First, the standards. Air Force standards were derived from existing Army standards, which in turn, had been developed from actuarial statistics. In these older tables, the standard weight for a given height increases with age. On a longitudinal study, Graybiel⁴ has described the tendency for clinically healthy men to progressively increase in body weight with age.

Is there, however, any medical justification for complacent acceptance as "normal" of weight increase with age? Physiologically, body growth is complete at about age 25,⁵ after which time there is no increase in the number

of metabolically active cells. Experimental and laboratory evidence^{5,6} indicates that during each decade after age 25, the body loses about 3 per cent of its metabolically active cells. These

TABLE I. PROPOSED REVISION OF WEIGHT TABLES

| Sex | Height in Inches | Weight in Pounds | | |
|---------|------------------|------------------|----------|---------|
| | | Minimum | Standard | Maximum |
| Males | 60 | 105 | 122 | 140 |
| | 61 | 107 | 124 | 142 |
| | 62 | 109 | 126 | 145 |
| | 63 | 111 | 128 | 147 |
| | 64 | 113 | 131 | 151 |
| | 65 | 115 | 135 | 155 |
| | 66 | 117 | 139 | 160 |
| | 67 | 121 | 143 | 164 |
| | 68 | 125 | 147 | 169 |
| | 69 | 129 | 151 | 174 |
| | 70 | 133 | 155 | 178 |
| | 71 | 137 | 159 | 183 |
| | 72 | 141 | 164 | 189 |
| | 73 | 145 | 169 | 194 |
| | 74 | 149 | 174 | 200 |
| | 75 | 153 | 179 | 206 |
| | 76 | 157 | 184 | 212 |
| | 77 | 161 | 189 | 217 |
| | 78 | 165 | 194 | 223 |
| Females | 60 | 99 | 115 | 132 |
| | 61 | 101 | 116 | 133 |
| | 62 | 103 | 118 | 136 |
| | 63 | 106 | 122 | 140 |
| | 64 | 108 | 125 | 144 |
| | 65 | 111 | 129 | 148 |
| | 66 | 113 | 133 | 153 |
| | 67 | 116 | 137 | 158 |
| | 68 | 121 | 141 | 162 |
| | 69 | 124 | 145 | 167 |
| | 70 | 129 | 149 | 171 |
| | 71 | 132 | 153 | 176 |
| | 72 | 136 | 157 | 181 |

active cells, if replaced, are probably replaced with metabolically inactive cells: for practical purposes, fat. Therefore, even if weight remains constant, the proportion of fat to body weight is very likely increased.

REVISED STANDARDS:

STABILITY OF WEIGHT WITH AGE

A Proposal.—Current Air Force weight standards tolerate weight increase with increasing age, an increase which appears, in our present state of knowledge, to be undesirable from

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Presented at the Aerospace Medical Association Meeting, April 27, 1961 in Chicago, Illinois

WEIGHT CONTROL—BEYER

medical and physiologic viewpoints. Since the Air Force recognizes the desirability of weight standards which will keep all personnel, regardless of age, in proper condition, it follows that a revision of the traditional weight table should be adopted and that the new standards should be enforced.

the field at the present time. From a scientific point of view, however, there are several aspects of the weight problem which need further study. For example, if an individual's weight falls within the weight limits specified by this table, obesity is not necessarily excluded. Nor do the tables allow the physician to distinguish

TABLE II. MEAN WEIGHT BY AGE OF 13,272 AIR FORCE OFFICERS ON FLYING STATUS

| | 68 Inches Tall | | | | 72 Inches Tall | | | |
|----------------------|----------------|-------|-------|-------|----------------|-------|-------|-------|
| | 20-24 | 25-29 | 30-39 | 40-49 | 20-24 | 25-29 | 30-39 | 40-49 |
| Number of men | 1147 | 1332 | 2680 | 927 | 1466 | 1746 | 2973 | 1001 |
| Mean weight (pounds) | 155 | 158 | 163 | 163 | 173 | 177 | 182 | 183 |
| Standard deviation | 14.9 | 15.3 | 15.4 | 15.8 | 17.3 | 17.4 | 17.4 | 17.1 |

In 1960, while considering revision of the standard Air Force weight tables, the Surgeon General, United States Air Force, requested that the Commandant of the School of Aviation Medicine undertake the development of revised height and weight tables for Air Force personnel. A proposed revision of the tables was made and forwarded to the Surgeon General later in the year. Table I contains the proposed revision. The standard weights in the revised tables are somewhat less than those currently permissible. It should be noted that this revision is similar to the recommended weight tables prepared by the Metropolitan Life Insurance Company as reported by Halpern, Glenn and Goodhart.⁷ The Air Force tables allow a few pounds above and below the maximum and minimum allowances respectively as reported in the Metropolitan tables. The minimum proposed Air Force weight is that currently allowed as minimum for ages 18 to 20. The standard weight proposed is that currently used for the age group 26 to 30. The proposed maximum weight is the standard weight plus 15 per cent, as was suggested in the general guidance received from the Surgeon General for the preparation of the revised tables. The School recommended that these weight standards be used for all individuals 18 years and older.

These proposed tables provide a practical and needed guide to be used by physicians in

those who are overweight and not obese, or those who are obese and not overweight. A more complete study of the body build of Air Force personnel and its relationship to their morbidity and mortality needs to be made.

A Pilot Study.—How great will be the problems when new and more stringent weight standards are published and enforced? To answer this question, we may ask two others: (1) Under the present standards, have Air Force personnel gained weight with age? (2) What per cent of flying personnel are presently above tolerable limits, as set by the revised tables?

At present, we cannot answer the question for the entire Air Force population; however, at the School of Aviation Medicine, a pilot study has been made of the weight increase with age. It must be emphasized that this study was of the cross-sectional rather than longitudinal type; in this study, therefore, the phrase "as age increased" refers not to increasing age of one group of men but to *group-age*, with different men comprising each group.

From a total of 42,600 electrocardiographic records of Air Force officers on flying status, two sub-sets were drawn: (1) all men of recorded height 67.5 through 68.25 inches, and (2) all men of recorded height 71.5 through 72.25 inches. These two groups will be referred

WEIGHT CONTROL—BEYER

to respectively as the 68-inch and the 72-inch groups. These heights were chosen arbitrarily, representing men who are 2 inches below or 2 inches above the average height of Air Force flying officers, which is approximately 70 inches.

was 25 per cent or more above standard. The standard chosen is the weight currently given in AFM 160-1 as standard for the age group 26-30, and newly recommended as the standard for all ages. It can be seen from Table III

TABLE III. PER CENT OF 13,272 AIR FORCE OFFICERS HAVING WEIGHTS AT LEAST 15 PER CENT ABOVE STANDARD

| | 68 Inches Tall | | | | 72 Inches Tall | | | |
|---------------------------------------|----------------|-------|-------|-------|----------------|-------|-------|-------|
| | 20-24 | 25-29 | 30-39 | 40-49 | 20-24 | 25-29 | 30-39 | 40-49 |
| Number of Men | 1147 | 1332 | 2680 | 927 | 1466 | 1746 | 2973 | 1001 |
| Per cent of the men whose weight was: | | | | | | | | |
| 15 per cent or more above standard* | 18.9 | 25.9 | 34.4 | 36.1 | 20.2 | 27.2 | 34.8 | 37.7 |
| 25 per cent or more above standard* | 2.4 | 4.2 | 10.0 | 10.5 | 3.3 | 4.8 | 9.7 | 12.0 |

*Standard weight is the weight given in Air Force Manual 160-1 under "standard" for age group 26-30.

Within height groups, the men were divided into age groups, as shown in Table II. For each age group, the mean weight and standard deviation were computed. Inspection of Table II shows that, for both height groups, mean weight increased as group age increased for age groups 20-24, 25-29, and 30-39. Application to these data of Duncan's Multiple Range Test for heterogeneity of means shows the differences between these three means were statistically significant at the 0.001 level. For the 68-inch group, there was no difference between the means of the 30-39 and 40-49-year age groups, and, for the 72-inch group, the small difference (1 pound) between the two age groups was not statistically significant at the 0.05 level. Whether differences of these sizes are of medical significance remains to be answered by additional research on the association between weight increase and morbidity as age increases.

Now, to answer the second question—what per cent of the men of height 68 or 72 inches were above tolerable weight limits, as set by the revised table?

Table III shows the per cent of men in each age group whose weight was 15 per cent or more above standard and the per cent whose weight

that, as group-age increased, increasing percentages of men in both height groups had weights 15 per cent or more above standard. Similarly, the percentage of men having weights 25 per cent or more above standard became larger with increase in group-age.

SUMMARY

Medical evidence indicates that overweight is an important factor in degenerative diseases. Therefore, overweight can be a threat to the continued effectiveness, health, and longevity of Air Force personnel, and, in extension, to the mission of the Air Force itself.

The weight standards traditionally accepted by the Air Force permit weight gain with age, an increase which is physiologically unsound and medically unsafe. Acting upon the request of the Surgeon General, United States Air Force, for a re-evaluation of weight standards, the School of Aviation Medicine proposed a revision of the current standards, essentially making the current weight standard for ages 26-30 applicable to all ages.

Data are presented showing the results of a cross-sectional type pilot study of the relationship between age and weight among 13,272 Air Force officers on flying status, height 68

or 72 inches. Although not definitive, these data suggest that there is evidence of weight increase with group-age increase during the two decades between 20 to 40 years. Although mean group-weight is the same for age groups 30-39 and 40-49, the percentage of men whose weights were at least 15 per cent above standard increases with group-age for the three decades from 20 to 49 years. These data suggest that we can anticipate weight reduction and weight control problems when new standards are introduced.

Since all Air Force flyers and all fighting personnel must be in top condition at all times to complete their military assignments, the United States Air Force can no longer afford to tolerate overweight and obesity. The rewards of weight reduction—greater efficiency, better health, longer life—are commensurate with the effort necessary to achieve this goal.

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Acute Glomerulonephritis in Elderly Patients

It is commonly considered that acute glomerulonephritis is a disease of childhood, adolescence and young adulthood. However, a considerable number of patients of advanced age have been seen with acute glomerulonephritis in the cardiorenal clinics and in the general wards of two large hospitals in the U.S.A. A recent communication by Samiy, Field and Merrill (*Ann. Int. Med.*, 54:603, 1961) reports seven cases of acute glomerulonephritis in patients aged 60 years or more; the youngest was 62 and the oldest was 81. Four were male and three were female. The most common symptoms were dyspnea, edema and oliguria. Only three of the patients reported antecedent sore throats or upper respiratory infection. Of all the throat cultures, examined in five cases, only one was positive for beta hemolytic streptococci. The antistreptolysin titre was determined in three

patients, and was found to be elevated in all. The majority of the patients developed hypertension. Examination of the urine invariably revealed proteinuria and macroscopic or microscopic hematuria. Blood casts were identified in two cases. The correct diagnosis was considered at the time of admission to hospital in only one case. Three of the patients, those with the most advanced disease, died in hospital. The most common cause of death was a fulminating pulmonary infection. The high mortality in this series is possibly explained by the presence of underlying chronic illnesses such as diabetes mellitus or coronary heart disease.

It is emphasized that acute glomerulonephritis is not restricted to a specific age group. Its presence should be taken into consideration in patients of any age.—From the *Canadian Medical Association Journal*, 1961.

Aeromedical Aspects of Turbo-Jet Commercial Aircraft

CHARLES C. GULLETT, M.D.

COMMERCIAL AVIATION has taken a giant step forward in progress, with the introduction of the turbo-jet powered aircraft. In some circles this has been referred to as the "jet-revolution." The approximate doubling of cruise speeds and seat capacity is having multiple effects on the airline operators, crews, passengers and even the public in general. Some phase of this "jet-revolution" is frequently the topic of conversation, whether it be airports, officers, barber shops, or physicians' offices. The jetliner seems to be just one phase of this "revolution," which could include the recent developments in atomic energy, missiles, and the exploration of outer space. Some of these feats have been so fantastic to the average man that he is almost willing to accept anything said or done as being fact and just part of this era. As a result, there are many misconceptions being perpetuated. A wide variety of occurrences are being attributed to ultrasonic vibrations, sonic booms, radioactive fall-out, cosmic radiation and G-forces.

We have attempted to assemble the current known facts in regard to many of these factors in regard to the jet transports and their effect on the passengers and particularly the cabin attendants. Although there are many types of jet transports in operation throughout the world, our experience has been with the Boeing 707 and the Convair 880. These aircraft are both powered by four turbojet-type engines, and are certified to operate to 42,000 feet.

Radiation Hazards.—The publicity given to nuclear detonations and the associated radio-

active fall-out has made the general public conscious of radiation hazards.^{3,8,11,13,16-18} Investigations and monitoring programs in this field have been in operation for many years. The use of rockets and satellites has contributed greatly to the information in this area. At the present time in commercial aviation, we are not confronted with the potential problems that exist beyond the earth's atmosphere. Considerable attention has been given to the worldwide Strontium-90 buildup, and the accumulation of very fine particulate, fission-product debris in the stratosphere. Monitoring for airborne contamination by the Air Force and by various airlines has involved taking readings in cabins, air vent filters, external aircraft surfaces, and its cleaning equipment. Cockpit and air vent readings were all essentially normal background levels. Exterior surface areas were increased, in areas of increased airflow, as a result of the concentration by the venturi effect of the air stream. The levels were below permissible levels established by the National Committee on Radiation Protection (NCRP).

Cabin Pressurization System.—Another element of high altitude flying is the hazard of exposure to low atmospheric pressure. Commercial jet transport manufacturers have attempted to design this hazard out of the jet airplane. The fuselage is designed with a fail-safe, rip-stop construction which prevents the spread beyond the stops, or disintegration in case of accidental puncture, or failure of the skin. The cabin doors are all plug type from the inside, hence pressurization prevents accidental opening at altitude. The windows and windshields are multiple thickness, each layer having capability of withstanding greater pres-

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sure differentials than the aircraft operates under. This has been confirmed in actual operation, where a pane has cracked, but no pressure failure has occurred. Any one of three

the crew to don their masks* and start the aircraft down to a safe altitude. At a 14,000-foot cabin equivalent the passenger oxygen masks stored in the overhead service compart-

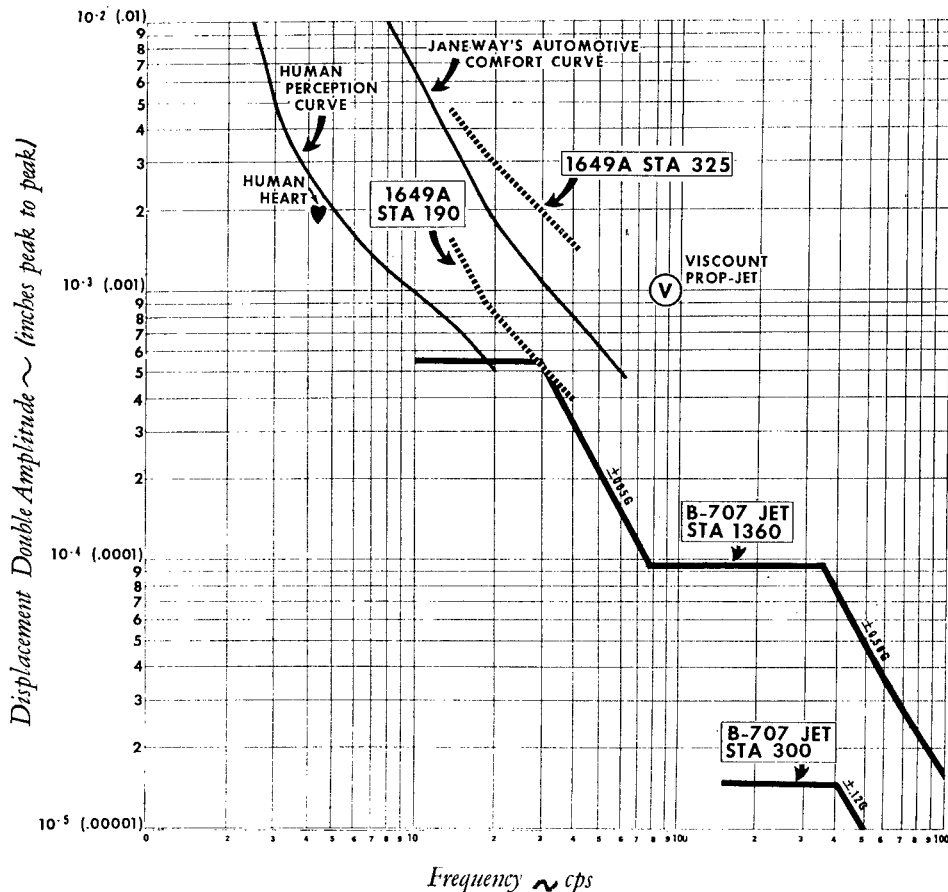


Fig. 1. Vibration environment.

separate compressors is capable of maintaining cabin pressurization of 8.6 p.s.i. The pressure control relief vents have an automatic closing device. In case of loss of compressor inflow, they seal the cabin and maintain an adequate 13,500-foot equivalent until pressure is restored, or the aircraft is taken to safe altitude. Finally as a backup, in case of failure of any part of the system and the cabin begins to lose pressure, an automatic oxygen supply system goes into operation. When the cabin reaches a 10,000-foot equivalent, a warning system further alerts

ment drop in front of each passenger for easy donning and use until the aircraft is taken to a safe altitude. Portable oxygen bottles are also available for cabin attendants' use after a decompression, or for first aid oxygen for an ill passenger at other times.

Vibration Environment.—The vibration characteristics are one of the outstanding improvements in the turbo-jet transport, which even the

*One pilot is normally on oxygen above 35,000 feet.

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first rider will appreciate. Mechanical vibration and its effects on man have been of interest to medical people for a long time. Civil Air Regulations require that vibration shall not interfere with the safe operation of the airplane. Vibration equivalents can be expressed in a variety of units or terms. This sometimes leads to difficulty of interpretation for the average person. Goldman⁶ used the term g-units, using acceleration rather than displacement and velocity as an expression of motion. Medical literature on ballistocardiography deals primarily with displacement, using units of thousandths of an inch per second, at the natural body frequency of 4.3 c.p.s. This normal displacement averages about .0022 inches. Janeway established a comfort level curve used as a standard in the automotive industry. Getline⁵ and Goldman⁶ have established vibration perception curves, comfort curves, and maximum military aircraft tolerance curves. Figure 1 shows a composite of these curves and superimposed is Lederer's¹⁰ vibration constant for the early Viscount at average cruise level. The author has further superimposed vibration ranges from two cabin location extremes for the 1649-A Constellation⁷ and also two envelopes to show the measured vibration environment, which is representative of forward and aft portions of the cabin of the Boeing 707. The marked drop in the amplitude of the vibrations on the jet is readily apparent.

The vibrations in propeller driven aircraft originate predominately from the tips of the propellers as they move by the fuselage. The frequency of the resulting vibration will be dependent on the propeller RPM/engine gear ratio. The Convair liner has a 0.45 to 1.0 ratio; the 1649-A Constellation has a 0.35 to 1.0; and the turbo-prop Viscount has 0.10 to 1.0. Since the turbo-jet transport is not driven by propellers this source is not present. The amplitude of vibration is inversely proportioned to the frequency by the following formula

$$\frac{V^*}{2 \pi f}$$

*V=Velocity. f=Frequency.

TABLE I. CABIN FLOOR ANGLES

| | Model | |
|---------------------------------|---------------------------|--|
| | B-707 Jet 0-30,000 ft. | 1649A Constellation 0-15,000 ft. |
| Start of climb angle | 8.3° | 9.1° |
| End of climb angle | 4.4° | 7.9° |
| Average climb angle | 6.0° | 8.6° |
| Duration of climb | 22 min. | 15 min. |
| Incline/distance ratio in feet | | |
| Fwd galley to first class sect. | 2.5/23 | 5/32 |
| Aft galley to tourist section | 2.0/19 | Only one galley |

The amplitude of the vibration produced by the high speed jet turbine is very low. Another factor in the comfort of the jet is that the ease of attenuation of vibrations is related to the frequency. In other words the higher the frequency, the easier it is to attenuate. Consequently, the high frequency, low amplitude jet vibrations are more easily and completely attenuated by the insulation, floor carpets, and seat upholstery, than are the propeller produced vibrations.

Airconditioning System.—The airconditioning systems of the Jetliners have a very high capability in maintaining a small range of fluctuation throughout the cabin. The refrigeration units are designed for on the ground operation also, which adds to the comfort of the passengers boarding on a hot day. The ventilation system is a non-recirculating type, hence a constant flow of fresh, odorless, clean air, which is low in humidity at the higher altitudes. This is normally considered desirable as is amply demonstrated by the high patronization of low humidity resort areas, like Arizona. On the longer higher altitude flight, the slight tendency for dehydration and increase in thirst is easily neutralized by a small increase in water consumption.

Climb Angles and Acceleration Forces.—The high speed of the jets and the initial take-off configuration has led to the misconception of high G-forces, and steep cabin floor angles during climb. It must be remembered that G-forces are really acceleration forces, or change in ve-

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TABLE II. G-FORCES FROM TAKE-OFF TO CRUISE ALTITUDE BOEING 707 AND LOCKHEED CONSTELLATION 1649A

| Weight (lbs.) | | Model | | | |
|---|---------------------------------------|-----------|---------|---------|---------|
| | | B-707-131 | | C-1649A | |
| | | 247,000 | 230,000 | 156,000 | 114,000 |
| Static conditions at start of take-off roll | Acceleration (ft./sec. ²) | 5.46 | 5.86 | 8.13 | 11.40 |
| | G-units | .170 | .186 | .252 | .354 |
| Speed = V ₂ | Acceleration (ft./sec. ²) | 3.88 | 4.20 | 3.86 | 5.69 |
| | G-units | .121 | .131 | .120 | .176 |
| Climb | Acceleration (ft./sec. ²) | | .253 | | .071 |
| | G-units | | .0079 | | .0022 |

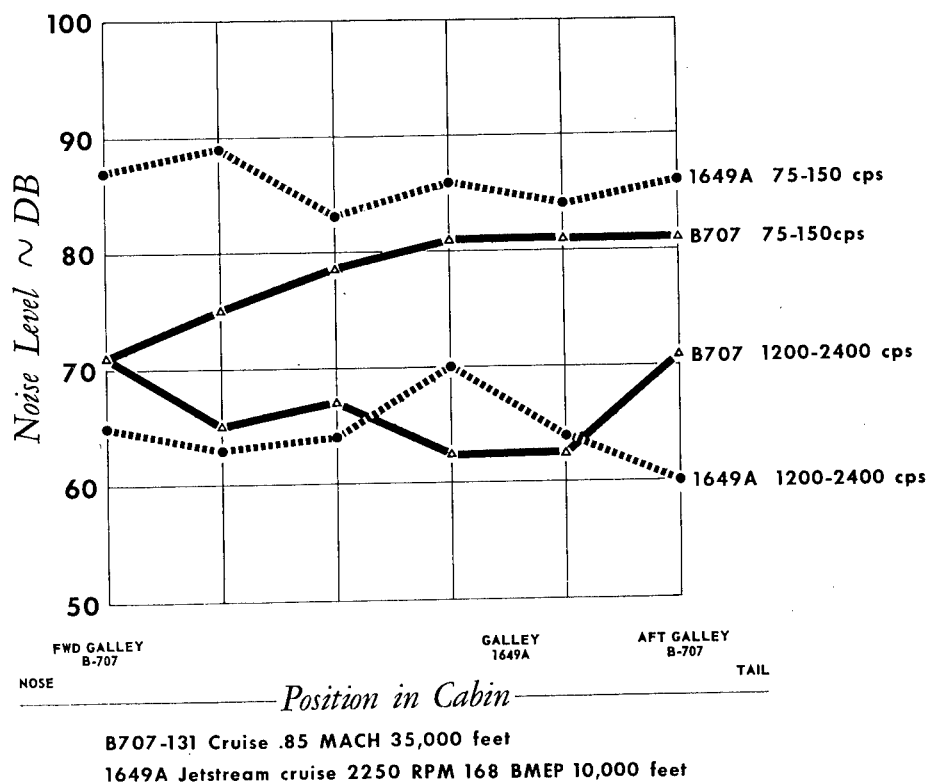


Fig. 2. Cabin noise levels of 1649A Jetstream and B-707-131.

locity, and not simple speed. Table I shows the comparison of the typical climb angles and their duration. The jet with its greater speed does not require as steep an angle of attack to obtain the same rate of climb. In neither aircraft are they significant as far as the passenger or cabin attendant is concerned in walking up and down the inclined aisle during climb or descent. The majority of the walking is done after cruise level

is reached. Table II compares the G-forces from brake release to cruise altitude. The heavy jet is slower accelerating after brake release, hence the lower G-force on the initial roll.

Noise Environment.—The noise environment, an important factor in comfort or annoyance and fatigue, has improved on the B-707. Figure 2 shows the cabin noise level in a C-1649A

and a B-707 from the fore to aft location, and recorded in decibels in two octave bands 75 to 150 c.p.s. and 1,200 to 2,400 c.p.s. Again the predominate noise on the C-1649A⁷ is produced

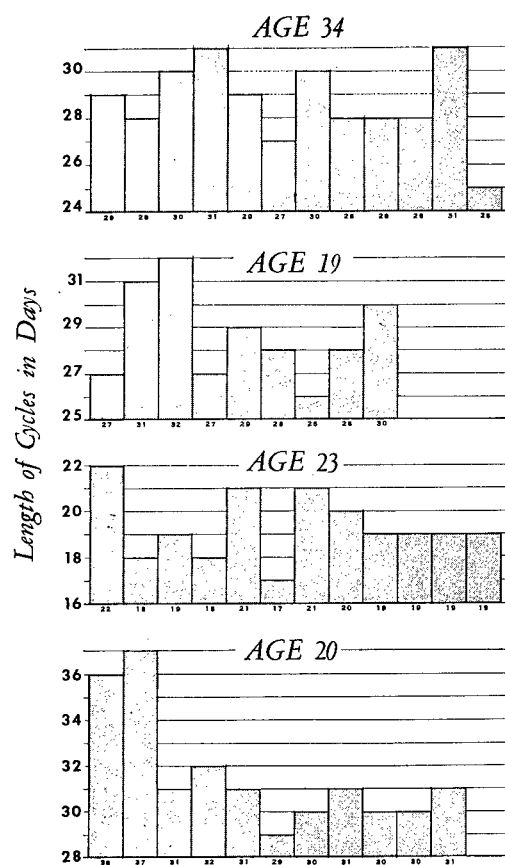


Fig. 3. Examples of lengths of successive menstrual cycles in normal young women considered as "regular."

by the propellers and lies in the 75 to 150 c.p.s. range. Consequently, this level is considerably higher than the B-707.¹² In the higher frequency range of 1,200 to 2,400 c.p.s. the noise level is less in both aircraft, with the jet being slightly higher in the tail section which is in the exhaust cone of the inboard engines. As can be seen, the average noise in the cabin of the jet is about the same as the business man normally finds in a busy office.

Medical Complaints of Hostesses.—Despite the generally favorable results of the investigation into all these factors, the airlines medical departments were very interested in observing the effects of the introduction of this new transport. Down through history it has been observed that the introduction of new equipment usually brings a temporary increase in anxieties, and physical complaints of various types, which abate as familiarity and confidence are gained through experience. We embarked on a very intensive and comprehensive training program, including high altitude physiologic indoctrination for all crews transitioning to the B-707. Despite this program we saw the mounting tensions and anxieties. Practically every type of physical ailment or distress that developed was attributed in some way to the jet airplane by some of the jet hostesses. Fatigue was an early predominant complaint, and one factor that added to this was the exceptionally high load factor during the early months of introduction of the jet. After three or four months experience many of the hostesses began to praise the jet as the greatest plane they had ever flown. One of the early complaints, which gained considerable publicity, even in the newspapers and lay magazines, was menstrual irregularities and dysmenorrhea. Although it is a well known fact among physicians seeing large numbers of young women in the third decade of life that these complaints are very common, the high incidence was not realized by these girls and apparently many practicing physicians. Absolutely regular cycles in young women is the exception rather than the rule. As Fluhmann⁴ has stated, the girl whose cycle is as regular as clockwork is really a Märchenprinzessin—a princess out of a fairy story. Many normal young women who have always considered themselves very regular are surprised to find how irregular they are when an accurate calendar record is maintained. Figure 3 illustrates a few examples of this. A survey of our TWA annual physical examination records revealed an incidence of approximately 52 per cent of the hostesses flying piston aircraft admitted to some type of abnormality

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in their menstrual history. The extrinsic and intrinsic causes of dysmenorrhea cannot be accurately differentiated by means of questionnaires. Resulting variations in the incidence are well illustrated by numerous references quoted in 1938 by Davis.²

lating of the frequency with which psychogenic factors are responsible for menstrual dysfunctions, and the physiologic mechanisms by which this occurs are becoming increasingly clear.¹⁴ However, at times many of these patients do not offer surface evidence of emotional problems and

TABLE III. STATISTICS ON 100 HOSTESSES FLYING PROPELLER-DRIVEN AIRCRAFT

| | Range | Mean | Standard Deviation | Coefficient of Variation |
|---------------------------------|-----------|-------|--------------------|--------------------------|
| Age (years) | 21-38 | 24.5 | 4.23 | 17.6 |
| Weight (pounds) | 100-144 | 121.6 | 9.93 | 8.1 |
| Blood pressure (mm.Hg) systolic | 94-140 | 114.3 | 9.94 | 8.7 |
| diastolic | 50-86 | 64.3 | 8.11 | 12.7 |
| Hemoglobin (grams) | 11.7-15.9 | 13.9 | 0.91 | 6.5 |
| Menstrual abnormality | 52% | | | |

Among large groups of gynecological patients the incidence of dysmenorrhea varied from 8 to 47 per cent; in school girls and university women from 17 to 86 per cent; in industrial workers from 80 to 93 per cent; in shop assistants 34 per cent; and in supposedly normal women not classified in regard to occupation, from 31 to 84 per cent. The incidence is high, but included are instances of relatively mild discomfort. This is chiefly due to the manifest difficulty of interpreting the subjective symptom "pain" by different individuals.

many present a façade of poise and maturity which conceals underlying instability.

Table III lists some of the pertinent medical findings on 100 hostesses flying propeller type aircraft, selected at random from the domestic system. Table IV shows the same type of data before and after duty on the jet of the first 100 hostesses taking annual physical examinations after jet duty. The marked similarity of the findings on the two groups is noted. There is no significant difference between the control group and the jet group, nor is there significant

TABLE IV. STATISTICS ON 100 HOSTESSES BEFORE AND AFTER FLYING ON JET AIRCRAFT

| | Range | | Mean | | Standard Deviation | | Coefficient of Variation | |
|---------------------------------|---------|-----------|--------|-------|--------------------|-------|--------------------------|-------|
| | Before | After | Before | After | Before | After | Before | After |
| Age (years) | 20-36 | 21-37 | 23 | 24 | 3.2 | 3.2 | 13.4 | 13.4 |
| Weight (pounds) | 99-141 | 98-146 | 118.6 | 119.8 | 9.1 | 9.4 | 7.7 | 7.8 |
| Blood pressure (mm.Hg) systolic | 90-146 | 90-154 | 113.3 | 114.6 | 10.8 | 10.9 | 9.6 | 9.5 |
| diastolic | 40-90 | 44-94 | 67.8 | 64.6 | 9.7 | 8.8 | 14.3 | 13.6 |
| Hemoglobin (grams) | 10-15.9 | 10.3-15.9 | 13.7 | 14.0 | 1.0 | .9 | 7.4 | 6.7 |
| Menstrual abnormality | 49% | 32% | | | | | | |

Statements have been made that exposure to heavy work, vibration, constant reaching and stretching may cause or aggravate abnormal menstruation and other gynecologic conditions, but proof of this is lacking.¹ The incidence varies greatly in different industries, since this condition is affected by psychologic factors and is often used as an excuse for other causes of absences. More and more evidence is accumu-

change in the jet group after duty. Note the incidence of menstrual complaints was 49 per cent among jet hostesses before jet duty and 32 per cent after jet duty.

SUMMARY

The results of this study were quite interesting and informative. We are experiencing the effects of an important advance in commercial

aviation. The jetliners are offering the public the finest means of transportation in the world today. We can assure them there is no hazard from radiation from high altitude of today's jetliners. The pressurization system has the highest capability and reliability of any aircraft in the sky, and backed by an automatic oxygen presentation system in the very remote event of failure. From the standpoint of comfort in flying, the jetliner is the finest. Physicians are finding this method of transportation the most desirable for their patients. The high speed makes a long trip short, and consequently less tiring because of time, less noise and vibration, lower and more reliable cabin altitude equivalent, hence higher partial pressure of oxygen. This is extremely important in the coronary insufficiency, angina pectoris, or infarct patients. The relaxing, vibrationless ride also makes the jet first choice for the obstetrical patient.

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Liver Function with Sickle-cell Anemia

Proper nutrition at an early age for patients with sickle-cell anemia may avert or delay onset of liver disease. Hepatic function is impaired in all persons, even young and relatively asymptomatic patients, with sickle-cell anemia. The severity of hepatic dysfunction does not seem related to the degree of anemia. Most patients have abnormalities in activity of serum lactic dehydrogenase (SLD), glutamic oxaloacetic transaminase (SGOT), and glutamic pyruvic transaminase (SGPT) and in serum proteins.

All of fourteen patients with sickle-cell anemia had hepatic dysfunction. Abnormalities in the activity of SLD, SGOT, and SGPT were detected in all patients except one, whose serum proteins were also normal. Most often, serum albumin was decreased, gamma and beta globulins were increased, and the albumin-globulin ratio was reversed. Prothrombin concentration was low in most patients.—G. HILKOVITZ, M.B., and A. JACOBSON, *J. Lab. & Clin. Med.*, 57:856-867, 1961.

Operational Use of the United States Air Force Partial Pressure Suit

CAPTAIN CHARLES L. WILSON, USAF, MC

THE USE of the currently operational United States Air Force MC-3A partial pressure suit is described in this paper and five problem cases are discussed which occurred when the suit was improperly used.

One hundred per cent oxygen under a positive airway pressure of 30 mm. Hg will afford reliable pilot protection in the event of a cabin decompression at 45,000 feet. It is possible under certain experimental conditions to protect some pilots at 50,000 feet with the same positive airway pressure, but many subjects become unconscious and others develop dangerous tachycardia.^{6,7} Balke¹ reported that two subjects were able to remain conscious at 56,000 feet while wearing a pressure-breathing oxygen mask without suit counterpressurization. However, this group was acclimatized to altitude and in excellent physical condition. Ernsting³ also reported unconsciousness and tachycardia in subjects with marginal physiologic protection at 56,000 feet. Randel⁵ reported similar results with the T-1 partial pressure suit.

A pressure suit is indicated when flying at altitudes between 45,000 and 50,000 feet and is absolutely necessary above 50,000 feet.

The USAF MC-3A partial pressure suit ensemble pressurizes all of the body except the feet. Regular boots offer enough foot protection. Three methods are used to apply pressure to the body through MC-3A pressure suit.

Head and Neck:—Gas pressure is applied directly against the skin and is retained by the helmet (MA-2) and face plate.

Torso:—A tailored rubber bladder is located next to the skin of the torso and is covered

by a non-stretching nylon outer garment. The bladder under the nylon cover is inflated and applies pressure to the underlying skin. Pressure within the bladder covers a body area similar to that covered by a vest and trousers extending to mid-thigh. The hands are protected by an inner-bladder and retainer glove.

Extremities:—The arms and legs are protected by capstans and fabric counterpressure is thereby applied to the skin.

The MC-4A ensemble contains a routine anti-g bladder in addition to the combination of techniques used in the MC-3A ensemble. The MC-3A pressure suit will protect personnel in a near vacuum (100,000 feet) from two to five hours.⁷

PRESSURE SUIT INDOCTRINATION AT A PHYSIOLOGICAL TRAINING UNIT

First Day.—While the subject is dressed in long cotton underwear, measurements are made of weight, height, neck circumference, chest, waist, sleeve and leg length, vertical torso length, and glove size.⁴ From these anthropometric values a selection can be made from twelve pressure suit sizes. While the suit is being laced the subject must be instructed to make frequent maximum inhalations so that no restriction of peak chest expansion occurs.

The pressure suit is issued him as his personal property. Commands have developed aircraft flight profiles so that pilots may experience operational pressure suit inflation at increasing altitudes under actual flying conditions.

After the subject is dressed in the ensemble he is exposed to MQ-1 console breathing (50 mm. Hg bladder and 5 psi capstan pressure for five minutes, and 70 mm. Hg bladder and 7 psi capstan pressure for seven minutes to

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familiarize him with the equipment. The afternoon session is devoted to a lecture on regulators and escape procedures.

Second Day.—In the morning, the subject is dressed in the pressure suit ensemble and exposed to a pressure of 100 mm. Hg bladder and 10 psi capstan for ten minutes in the MQ-1 console, and in the afternoon, he is redressed and denitrogenated for thirty minutes in the subject chamber. This is followed by a press-to-test.*

The chamber profile is as follows: ascent to 40,000 feet simulated altitude; level-off at 40,000 feet and allow subject to pass gas (rectal and oral) until comfortable; ascent to 65,000 feet and level-off for 1-2 minutes; return to 40,000 feet and experience a two-second decompression to 65,000 feet; return to sea level.

REPORT OF CASES

Case 1.—An unusual and potentially dangerous incident occurred but was immediately perceived by the experienced chamber crew and medical monitor. A press-to-test at ground level at the beginning of denitrogenation was normal. During the thirty minutes of denitrogenation, the subject moved around in the ejection seat (no parachute or harness). The bladder hose became sharply bent and pinched off between the subject and the ejection seat but was undetected. Just before ascent, the subject performed a press-to-test and noticed difficulty in breathing, but said nothing since he was not sure of the cause and confident that if anything were to go wrong, it would be quickly detected. The ascent to 40,000 feet simulated altitude was uneventful. When the climb to 65,000 began, the pressure gages indicated normal bladder and capstan pressures since the unseen pinch in the bladder tube was distal to the pressure gage outlet. The capstans inflated well and the subject began to experience increased difficulty during inhalation. When he relaxed after inspiration, the very tight suit assisted exhalation. An extremely vigorous effort was required to expand the chest during the next inspiration. Since the subject wore a K-2B flying coverall over the suit, it was difficult for the chamber observers to note inflation of the torso bladder. The glove bladders which are connected to the torso

bladder were definitely not inflated. Only a few seconds passed before the observers detected trouble and returned the subject to 40,000 feet where the pinched tube was discovered. The remainder of the flight was uneventful. If flying coveralls are worn, careful inspection of the glove bladders should give a clue to bladder inflation.

Case 2.—The subject was dressed in MC-3A partial pressure suit preparatory to indoctrination and denitrogenation for thirty minutes on 100 per cent oxygen. He was seated in the low-pressure chamber and all appropriate connections were made. Ascent in the chamber was made to 40,000 feet at which time the subject complained of intestinal gas and the flight surgeon directed descent to 20,000 feet. After the subject expelled gas, re-ascent to 40,000 feet was accomplished and he was maintained at this altitude briefly for instructions and observation. He denied gas pains but appeared to be uncomfortable and apprehensive. Ascent was started to 65,000 feet and at this altitude ECG tracings were obtained. The subject was instructed regarding the rapid decompression procedure and the chamber was recompressed to 40,000 feet. A rapid decompression to 65,000 feet was accomplished uneventfully and ascent was continued toward 100,000 feet. At 78,000 feet simulated altitude, the subject appeared distressed and did not respond to questioning. At this time he started to vomit and an emergency descent was instituted. He admitted excessive drinking and lack of food and rest before the indoctrination. At a later date he successfully completed the indoctrination program.

The following case demonstrates a near fatality which occurred in an aircraft and describes the elementary steps that must be taken to avoid such dangerous situations.

Case 3.—The F-104-A pilot in this case had a very tightly fitted MC-4A pressure suit. When dressed in the suit his maximum chest expansion was greatly reduced, abdominal expansion was decreased, and his face was beefy red. During the original fitting he complained that his suit was too tight but was assured that it was a proper fit. Since he had no previous experience with pressure suits he accepted the suit although it had been poorly fitted and was uncomfortable. His chamber indoctrination was uneventful.

He entered the aircraft and following a cockpit check, closed his facepiece and turned on the constant flow 100 per cent oxygen. By accident, his anti-g bladder was not connected to the aircraft gas supply. The pilot took off in formation at position

*A button on the survival kit. When the press-to-test button is pressed, the regulator delivers pressures to the bladder and capstans.

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Number Two, leveled off at 21,000 feet, and intentionally dumped cabin pressure as a part of the indoctrination procedure. At that time he did not recall increased respiratory difficulty after the intentional decompression. He accelerated and climbed to 31,000 feet at which time he apparently lost consciousness. His wing man stated that the subject rolled the jet over and went into a steep dive. The pilot recovered his aircraft at about 15,000 feet although he did not remember doing so. In a confused state he turned off his oxygen toggle switch in an attempt to turn it on. His wing man called frantically to him over the communication system without initial success. The confused pilot again pulled up into a climb. Again at about 31,000 feet the plane peeled off into a steep dive with a confused or unconscious pilot at the controls. By this time the wing man was shouting to the pilot, and fortunately his commands were acknowledged. The subject leveled off at 5,000 feet and the confusion quickly cleared. He turned his oxygen toggle switch on and returned to the air base.

This pilot could not use his chest expansion effectively because of the tight suit fit. When remeasured, it was demonstrated that his suit was too small, the laces entirely too tight and the neck seal too small. The difficulty became more serious when the gas trapped in the anti-g bladder expanded during ascent and hindered abdominal breathing. This situation is easily avoided by using a proper suit fit^{4,7} and connecting the anti-g bladder to the aircraft outlet.

It is interesting to speculate about the cause of loss of consciousness in the pilot. It could have been a vagotonic cardiac arrhythmia similar to fainting while holding one's breath,^{2,3} or it could also have been due to stagnant hypoxia subsequent to high intrathoracic pressures. It is important to realize that this situation can easily be avoided.

*Routine Use of the Partial Pressure Suit:—*Several commands have a requirement that the partial pressure suit be worn at frequent intervals (three or more flights a month). With frequent wear the pilots usually become adjusted to various unpleasant limitations that the suit imposes such as heat discomfort; restriction of lateral vision; only fair lateral head mobility unpressurized; and very little head mobility when pressurized. However as soon as the first squadron aircraft accidentally stalls at high altitude and the pressure suit automatically inflates to protect the pilot, there is a prompt cessation of objections.

This case represents an example of complications that nearly caused a fatality.

Case 4.—The pilot was wearing the MA-2 helmet and MC-3A partial pressure suit with the helmet tie-down ribbon loose so he could achieve greater head rotation with less effort (Fig. 1). At high

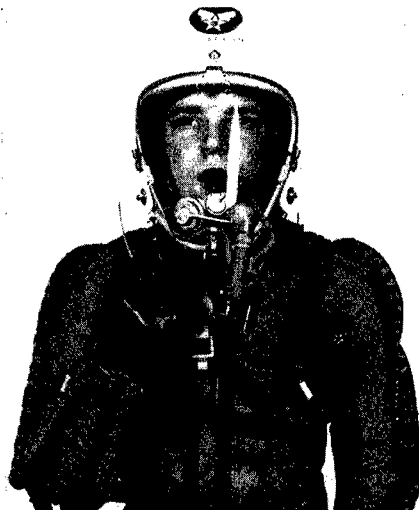


Fig. 1. Incorrect procedure. The subject is pulling the facepiece visor cord. The helmet tie-down ribbon is hanging from the pulley in the midline.

altitude, the engine compressor stalled and there was loss of cabin pressure during a 5 to 10-second period. The pressure suit immediately inflated and the helmet raised high on the pilot's head because it was not secure and blocked his vision. The pilot attempted to correct this and reached for his helmet tie-down ribbon but accidentally grasped the facepiece visor cord and pulled it down. Hence his facepiece opened and depressurized his pressure suit. Fortunately, the top hinge between the facepiece and helmet kept the plastic visor hinged to the helmet. The pilot realized his error and immediately locked the facepiece. The elapsed time between visor opening and closing is not known, but must have been less than eight seconds since the pilot did not experience hypoxia even after the facepiece was closed. In order to avoid a re-occurrence, his squadron now has golf-ball-sized objects hanging from the end of the helmet tie-down ribbon so there can be no question regarding the correct cord to be pulled. Some squadrons have a device to doubly lock the face plate.

A case is presented which illustrates dangers that arise from careless maintenance of pressure suit accessories.

PARTIAL PRESSURE SUIT—WILSON

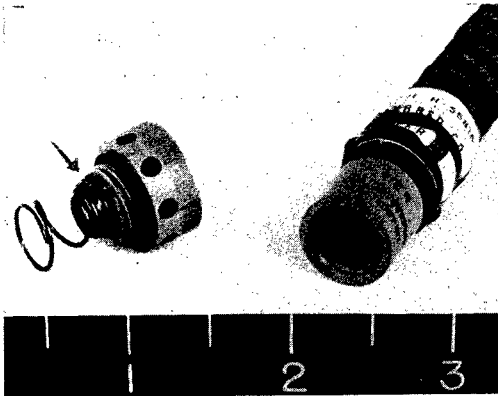


Fig. 2. The rubber gasket is improperly seated in the capstan bleed-off valve (Case 5).

Case 5.—A pilot, dressed in his MC-3A partial pressure suit and MA-2 helmet, entered an F-104-A aircraft, and attached his suit to a seat kit with a new regulator. He flew the aircraft on a research and development mission at 35,000 feet at which time he intentionally depressurized the cockpit and instituted a rapid ascent toward 65,000 feet. His suit pressurized and functioned properly. He returned to the base and terminated the mission successfully.

The next day this pilot wore the same partial pressure suit and helmet connected to an F-1 regulator which had previously been checked by authorized personnel and reported to be in satisfactory working condition. He flew the aircraft to 35,000 feet, intentionally depressurized the cabin, and started rapid ascent toward 65,000 feet. At 40,000 feet, the aircraft compressor stalled and he immediately throttled out of "after-burner" for a few seconds. After recovery the engine was throttled into "after-burner" again and an ascent was made to 55,000 feet but he returned to 45,000 feet and remained there for fifteen minutes. While the compressor was stalled and during ascent to 55,000 feet, the pressure suit and capstans inflated. However, the pilot noted a greater pressure on his chest than on his extremities which indicated inadequate capstan pressure. The pilot also noted that he was hypoxic. This lessened during his stay at 45,000 feet. The flight was terminated without re-ascent above 45,000 feet. He noticed a mild pain beneath his sternum when he took a deep breath one hour after the flight but this abated shortly thereafter. He was carefully examined sixteen hours later and found to be normal.

The partial pressure suit fit was re-evaluated and judged adequate. The F-1 regulator was statically tested and it was found that the rubber gasket in the capstan bleed-off valve was improperly seated (Fig. 2) so that it did not retain pressure satisfactorily.

CRITERIA FOR ASSESSING PROPER PRESSURE SUIT FIT

The subject must be able to make a *maximum inhalation* using chest and abdomen, without suit restriction. The subject must be able to stand *completely erect* with only very slight crotch or shoulder snugness. The subject must have a helmet neck seal cut large enough to avoid facial plethora.

Reliability of the Partial Pressure Suit.—In the several hundreds of experimental and operational uses of the partial pressure suit and regulator there has not been an aircraft accident or laboratory mishap where permanent injury or death could be attributed to the suit. It will require the constant attention of physiological training personnel, flight surgeons, and personal equipment personnel to maintain this record.

ACKNOWLEDGMENTS

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Tracking Performance During Low Frequency Vibration

T. M. FRASER, M.B., Ch.B., M.Sc., RCAF, G. N. HOOVER, Ph.D. and W. F. ASHE, M.D.

FREQUENCY OF VIBRATION, or functions predominantly of frequency, such as velocity, acceleration, or jerk, have long been regarded as the factors primarily responsible for the effects of whole body low frequency vibration in man.^{1,5,6,9-12}

There is no doubt that such physical entities as resonance and impedance are directly related to frequency and there is equally no doubt that vibration at relatively low frequencies (e.g. less than 50 cps) produces different clinical, physiological and pathological findings from those produced by vibration at relatively high frequencies (e.g. greater than 1000 cps).⁶

Less attention has been paid to the significance of amplitude, which has been frequently neglected, or even dismissed, as a lesser component of acceleration.

The majority of investigators in the field of whole body vibration, while employing many frequencies in the range of 1-100 cps, have seldom exceeded 0.1 inch single amplitude with man as a subject. Those few who have exceeded this amplitude have rarely combined it with a frequency of greater than 5 cps. Consequently, any assertion that the effects of vibration are predominantly related to velocity, acceleration, or jerk, becomes an unsupported extrapolation when it is applied to vibration with parameters outside that range. In fact it is not unreasonable to consider that beyond a certain threshold of amplitude the effect of amplitude might be of greater significance than that of frequency.

If this hypothesis were so, then inconsisten-

cies might be expected when the results of parallel experiments are compared in which findings have been interpreted in the light of the response to frequency without much regard being paid to the amplitude at which the experiments were carried out.

This may be illustrated by examining some of the results of tracking tasks. Thus, for example, Mozell and White,⁷ using subjects heavily restrained in a cushioned PBV bucket seat, found no decrement in performance of a non-vibrating tracking task on exposure of their subjects to vertical vibration up to 23 cps and amplitudes up to ± 0.05 inch. Gorrell and Snyder,⁴ on the other hand, exposing their subjects to vertical vibration at unstated amplitudes on a cushioned B-47 upward ejection seat, found a decrement in the performance of tracking tasks which they related to the effect of acceleration, in itself primarily a function of frequency. The greatest decrement was observed to lie at the upper end of their parameters, namely 30 cps and 1.54 G. This latter acceleration is considerably less, however, than the peak acceleration attained in Mozell and White's experiments.

Schmitz,¹² also found decrement in a similar tracking task which he too related to frequency, although in this case there were only two frequencies employed, namely 2.5 cps and 3.5 cps, while the associated amplitudes ranged to ± 0.25 inches.

Thus, in three similar types of task, under vertical vibration when the results are interpreted in terms of frequency and acceleration one shows no decrement in performance, another, using the same order of frequency, finds a decrement related to acceleration, and a third

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using very much lower and barely distinguishable frequencies again finds a decrement related to frequency.

To explore some of these inconsistencies fur-

To measure performance, a tracking task was devised, the display of which consisted of a matrix of 9 x 9 lights each 1 inch apart mounted on a grey background 12 x 12 inches. To pro-

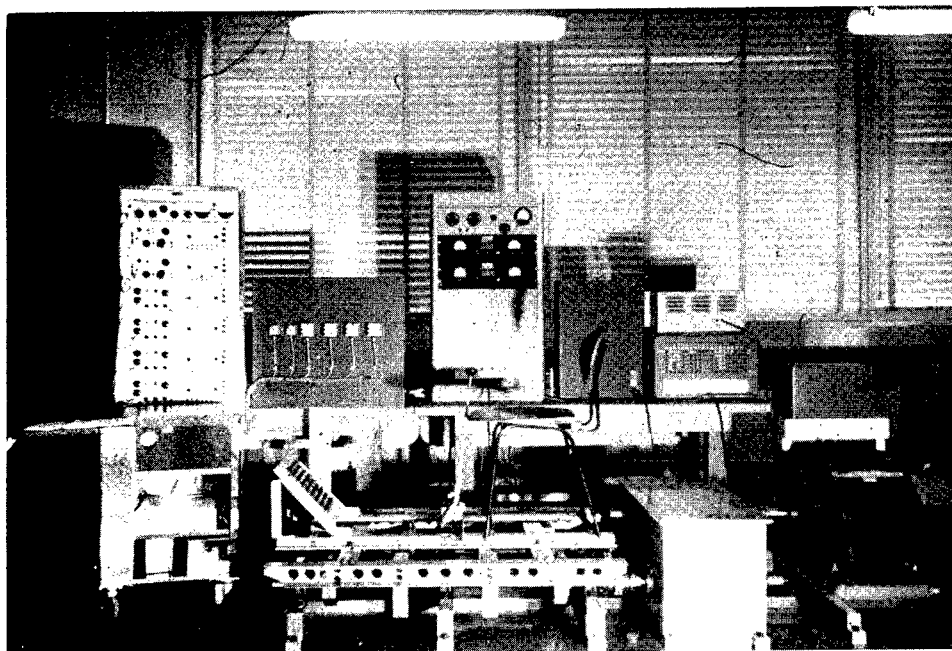


Fig. 1. Shake-table with seat and task display, control, and recording equipment.

ther and to determine in particular the effect of amplitude, the effect of plane of vibration, and the difference, if any, between tracking on a vibrating and a non-vibrating display, four healthy young subjects, two of whom were pilots, were randomly exposed to forty-eight different conditions of harmonic sinusoidal vibration at frequencies of, 2, 4, 7, and 12 cps, and amplitudes of $\pm 1/16$, $1/8$, $3/16$ and $1/4$ inch, in each of three planes, on a minimum damping hard wooden contour seat on a specially designed shake table (Fig. 1). The maximum peak acceleration to which the subjects were exposed was 3.63 G. To allow the subjects full opportunity to utilize their own damping potential they were totally unrestrained, and to minimize artifact no artificial damping was permitted. However, for standardization purposes, the subjects were instructed to adopt a consistent standard posture.

vide increased definition, the central light of the matrix was white, while the concentric squares were colored, blue, green, yellow, and red. The display was mounted on the superstructure of the table 45 inches from the eyes in the line of vision of the seated subject. By the use of signal generators and electronic relays a random pattern was fed into the display which gave the effect of a light continuously moving over its surface.

In front of the subject, within easy access, was mounted a control stick to which were attached potentiometers so arranged that manipulation of the stick caused the passage of signals into the display against those from the signal generators. By skilled use of the stick a subject could nullify the incoming signals and hold the central white light lit. All signals were passed to a transistorized analog computer to which was also tied a micro-switch timed for 58.5 seconds.

Closure of the micro-switch activated the system. The analog computer monitored the signals and integrated the subjects' error in volts in terms of distance of the light at all times from the central

tached from the table to the four frequencies and three planes in the amplitude in which the greatest decrement was observed when the display was in motion.

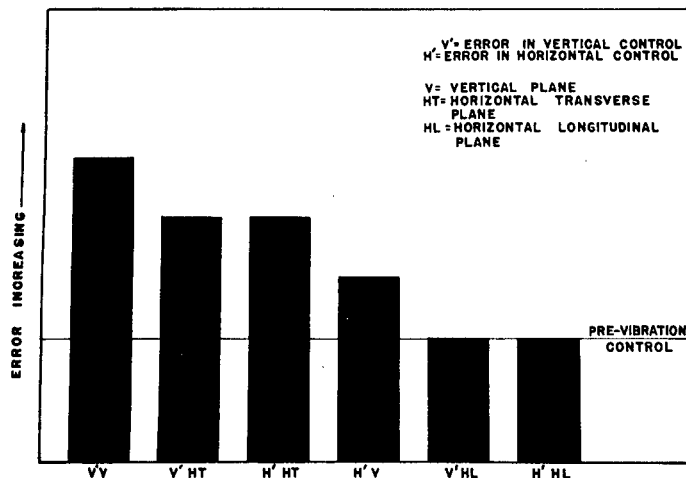


Fig. 2. Diagram of effect of plane of vibration on plane of stick control.

zero position and time at that distance. Error could be read out on a meter as vertical display error or horizontal display error.

METHODS

With all external factors similar except for vibration, each subject was trained to proficiency in control of the display in the nil vibration state.

During operational runs, each subject was exposed in turn on any one day at a randomly selected condition of amplitude and plane to two runs of sixty seconds' duration at each of four frequencies, the order of frequencies being randomized for each subject. Consequently each subject experienced two runs in each of the forty-eight conditions of amplitude, plane, and frequency. Non-vibration control runs were scored before and after each exposure.

To determine any significant difference in performance between the situation in which a display is static as compared with that in which it moves in conjunction with the subject, two of the subjects were exposed with the display de-

RESULTS

The error scores obtained when the display was vibrating with the subject were subjected to an analysis of variance, using as sources of variance the subjects, the amplitudes, the frequencies, and the vertical and horizontal display error scores as obtained from the computer.

To determine more closely the nature and significance of the interactions found, the analysis of variance was further subjected to a Duncan Range Test.²

This analysis demonstrated that the effect of vibration in the vertical plane and in the transverse plane was statistically similar and highly significant in comparison with that in the longitudinal plane, which in fact was not significantly different from the nil vibration state. Vertical control of the display during vertical vibration was however found to be less accurate than both vertical and horizontal control in transverse vibration. These in turn were less accurate than horizontal control under vertical vibration, whereas both horizontal and vertical control in longitudinal vibration were not significantly dif-

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ferent from control in the nil vibration state (Fig. 2).

Complex relationships were found between amplitude and frequency. When analysed for their individual effect, increase in either ampli-

any frequency with the lowest amplitude does not produce a decrement in performance; although *increase* in amplitude produces a decrement in performance that may be intensified by increase in frequency.

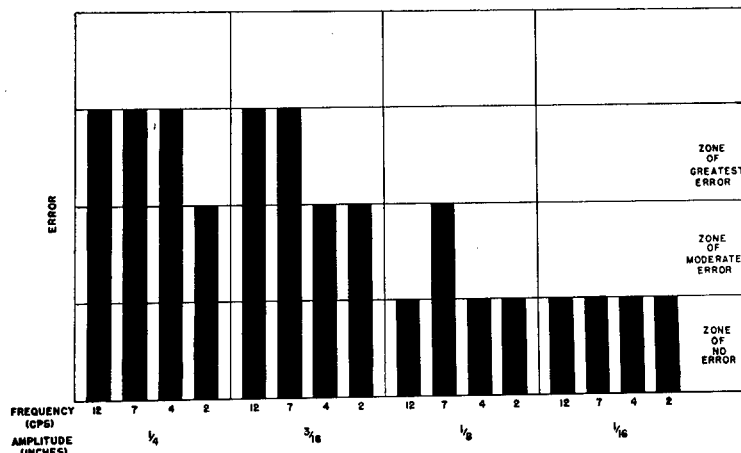


Fig. 3. Diagram of combined effect of amplitude and frequency on performance of tracking task.

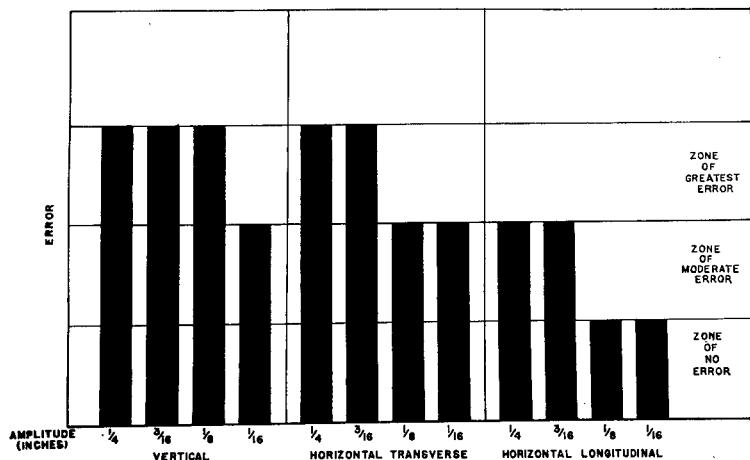


Fig. 4. Diagram of combined effect of amplitude and plane on performance of tracking task.

tude or frequency was found to be significantly related to decrement in performance. However, when the combined effect of frequency and amplitude was analyzed, amplitude was found to be the predominant factor, as may be observed (Fig. 3) by noting that a combination of

The importance of amplitude as compared with frequency in this study was again observed when the combined effects of amplitude and plane, and frequency and plane were analysed. In the former case (Fig. 4), as will be seen, the effects of plane alone which were previously

noted, (Fig. 2) become modified by the concurrent amplitude in that plane, such that a greater decrement is observed in any plane at the highest amplitudes. In the latter case, where the effects of frequency and plane are analysed

DISCUSSION

Examination of the foregoing findings indicates that in a task of this nature, where relatively high amplitudes are employed, and where control of the task is exerted on a freely moving

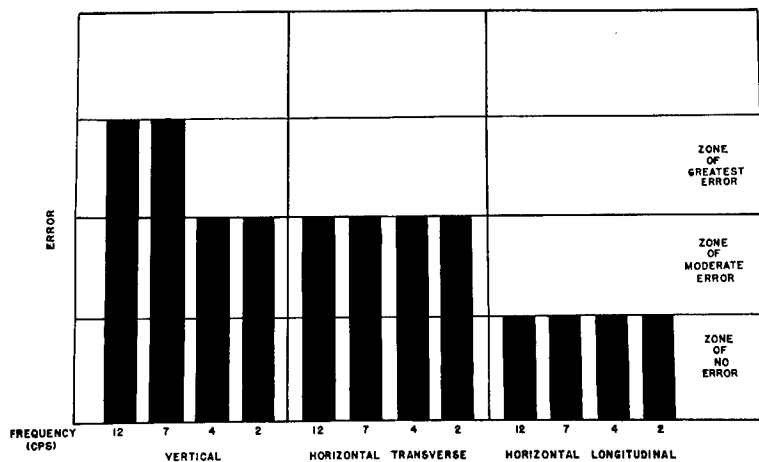


Fig. 5. Diagram of combined effect of frequency and plane on performance of tracking task.

(Fig. 5), the decrement due to plane alone can be seen to be unaffected by the frequencies in that plane, except at the highest frequency in the vertical plane.

As regards the difference between control of a vibrating display and control of a static display, the results of the series of runs on two subjects at $\frac{1}{4}$ inch amplitude, for which the display was detached from the table, were compared to the subjects' previous scores at that amplitude by a chi square technique.

Control of the static display was found to be significantly less accurate in the majority of combinations of frequency and plane. Although both subjects commented that because of increased blurring of the target light, the task was more difficult when the display was detached from the table, the response between subjects was inconsistent as regards the number and nature of the combinations of frequency and plane in which less accuracy was demonstrated.

stick by an unrestrained subject, the amplitude of the vibration becomes the factor of greatest significance in performance decrement. Subjectively, as has also been noted by Forbes,³ the precise co-ordination of the hand and arm is disturbed by the "flailing" effect produced by the vibration, and consequently the subject finds himself unable to maintain accurately the required track.

Amplitude however is not the sole factor. To determine the importance of different factors and functions, regression lines were obtained between mean score and amplitude, mean score and frequency, velocity, acceleration and jerk. Very poor correlations were found. With more complex power functions higher correlations were noted, but the highest, with $r = 0.87$ (Fig. 6), was obtained between mean score and the product of the amplitude and the square root of the frequency. The interpretation of this function is obscure, but it is of interest to note that Parrack and his group,⁸ point out that the fric-

tional resistance component of impedance is proportional to the square root of the frequency. Thus it may be that this function is an approximation to a more complex function embodying

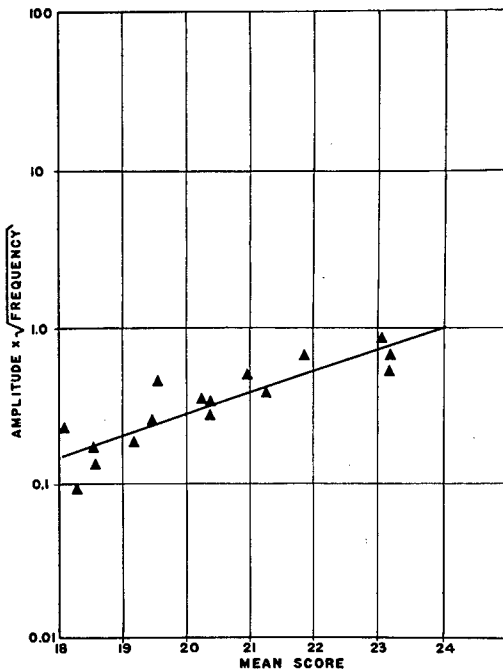


Fig. 6. Regression line—mean score versus amplitude $\times \sqrt{\text{frequency}}$, ($r = 0.87$).

amplitude and impedance. Recalling that the subjective intensity of a noise signal is determined by the amplitude of the sine wave concerned, one might also speculate that a function of amplitude and impedance might represent the subjective intensity of the vibration.

Whether or not this is so, it would appear that the performance decrement observed under the circumstances of this study is related to a function of amplitude combined with a fractional exponent of frequency. However, recalling that the body is a highly complex mechanical system capable of a wide variety of dynamic adjustment, and in view of the relationship to frequency, acceleration, and jerk, found by others working in different circumstances, it may be that no one function satisfies

all requirements, and that the exponent of frequency concerned may vary with differing circumstances, or that the total function involved may represent a summation of several different functions. This might be suggested by the tendency to curve, observed in some of the plots for this study, and by the fact that when score at different amplitudes is plotted directly against frequency two distinctly different types of curves are observed, one at lower amplitudes and one at higher.

With regard to comparison between control of a dynamic display as against a static display, there is no doubt that a significant, if inconsistent, difference exists. The fact that one subject, the most highly skilled in control, found less difficulty than the other, suggests that this problem might be overcome by training, but no definitive statement can be made before a more comprehensive comparison study is undertaken.

CONCLUSIONS

The conclusions from this study are that within the range of amplitudes, frequencies, and planes examined, in unrestrained subjects without artificial damping, exposure to harmonic sinusoidal vibration produces a decrement in tracking performance related primarily to the amplitude of vibration, although the function involved is probably modified by a dynamically varying function or functions of frequency. Performance is also observed to vary with the plane of vibration, the greatest decrement occurring in the vertical and transverse planes. Vertical and horizontal control of a display is also found to vary with the plane of vibration. A significant but inconsistent decrement is observed under most circumstances when the display does not vibrate in conjunction with the subject.

SUMMARY

Healthy subjects were exposed to harmonic sinusoidal vibration in forty-eight randomly selected combinations of three planes, four frequencies, and four amplitudes, namely 2, 4, 7, and 12 cps, and $\pm 1/16$, $1/8$, $3/16$, and $1/4$ inch. After training to proficiency in the nil

vibration state, the subjects' performance of a similarly vibrating tracking task was measured. Measurements were also made of the ability of vibrating subjects to track a non-vibrating task.

Decrement in performance was observed related to plane, and to function of amplitude modified by a fractional exponent of frequency. The significance of this is discussed.

A significant difference was observed between the performance of a vibrating task and a non-vibrating task.

ACKNOWLEDGMENTS

Grateful acknowledgment is made to Mr. L. B. Roberts, B.E. (Engineering) who designed the vibrating apparatus and gave much help, and to Mr. F. R. Johanson, who designed, built, and nursed much of the electronic equipment. The project was made possible by National Institute of Health Research Grant R.G. 5348.

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Mental Patients

Treating schizophrenics in general hospitals, a growing trend in Britain and parts of Europe, gives good results, according to a ten-year follow-up study reported recently in the *British Medical Journal*. Of the 95 schizophrenics studied, 75 per cent showed recovery, according to Drs. Peter Rohde and William Sargent of London's St. Thomas's Hospital.

Treatment after 1956 consisted mainly of chlorpromazine combined with electric convulsive therapy; insulin coma was used rarely, and then only when other treatment was unsuccessful. A factor in the successful outcome of the test may have been the atmosphere of hope surrounding the patient treated in the general hospital.—From *M.D.*, 1961.

Esophageal Carcinoma

An Example and Discussion of the Relentless Course of the Lesion

JOEL A. KAPLAN, M.D. and JAMES E. MAY, B.A.

MOST CASES of esophageal carcinoma present an interesting and varied clinical and pathological picture with unusual secondary effects. One such case is presented in this paper and followed by a brief discussion of the characteristics and complications of this lesion.

CASE PRESENTATION

This white man, aged sixty-six, with a history of alcoholic cirrhosis, diverticulitis and homologous serum jaundice (following a transfusion after a partial colon resection for the diverticulitis) began having progressive dysphagia four months prior to his admission to Evanston Hospital Association. He stated that various foods occasionally seemed to "stick in his throat just below the entrance of the esophagus." Most of the time the feeling of fullness and pressure was soon relieved, but occasionally some food was regurgitated. This regurgitated material did not contain blood. Chest x-rays, as well as esophagus and stomach x-rays, taken elsewhere three months prior to admission here were reported as normal.

Physical examination did not reveal any masses or nodes in the neck. Moist rales were heard bilaterally over the lung bases. The abdomen was distended, with both shifting dullness and a fluid wave present. The liver was enlarged 2 cm. below the right costal margin. He had bilateral palmar erythema.

Significant laboratory findings were a normal hemoglobin, WBC and differential. His prothrombin time was 62 per cent of normal and he had an elevated

bilirubin of 0.8 direct and 1.6 total. His BSP retention was 32 per cent and his transaminase was 100 units.

X-rays showed a ragged narrowing of the esophagus at the level of T-2 through T-5 (Fig. 1). This did not dilate during fluoroscopy. Esophagoscopy revealed



Fig. 1. X-ray of esophagus showing the marked circumscribed, ragged narrowing of its lumen. Upper portion approximates one-half normal size of esophagus.

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a fungating carcinoma about 3 cm. below the cricopharyngeal constriction. A biopsy of this was reported as epidermoid carcinoma of the esophagus.

He was treated with 5034 roentgens at the tumor in thirty-four days but following this he began having problems with an esophageal stricture. This necessitated frequent dilatations and shortly before he expired he required both a tracheostomy and gastrostomy as

ESOPHAGEAL CARCINOMA—KAPLAN AND MAY

palliative measures. His entire course, from the time of the onset of symptoms until his death, was progressively downhill.

The autopsy revealed a dense constricting carcinoma in the upper portion of the esophagus beginning at the level of the epiglottis and extending approximately 6 cm. caudad. The tumor had completely occluded the lumen and had also extended into the trachea and partially compressed that organ (Figs. 2 and 3). There was direct extension into both lobes of the thyroid (Fig. 4) and surrounding connective tissue, as well as skip metastases at lower levels in the esophageal mucosa. However, none of the blood vessels showed any invasion by the tumor. There was no evidence of any distant metastases in any lymph nodes and the liver was free of tumor although it showed evidence

intakes of extremely hot or alcoholic beverages had a bearing on the incidence of this neoplasm, but thorough studies have not substantiated these beliefs. At present, the enigma remains and only certain statistical facts can be stated with certainty. The lesion is most common in the fifth



Fig. 2. Gross photograph showing complete replacement and occlusion of esophagus by tumor (center) with compression of trachea (upper center) and invasion into thyroid (upper left). The carotid arteries can be seen on the lateral margins and these are uninvolved.

of healed post-necrotic cirrhosis. Microscopically, the esophagus showed complete replacement by dense sheets of tumor cells. These cells had indistinct walls and large pleomorphic nuclei undergoing unorderly mitoses. Numerous mitotic figures could be seen.

DISCUSSION

There have been various theories advanced regarding the etiology of carcinoma of the esophagus.¹⁻³ At one time it was surmised that large



Fig. 3. Photomicrograph showing marked narrowing and compression of the trachea by diffuse invasion of squamous carcinoma (left side). The tracheal cartilage is visible on the right.

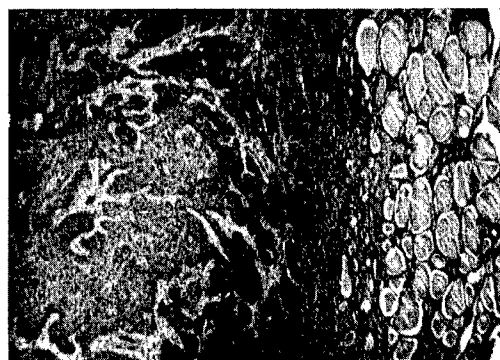


Fig. 4. Photomicrograph showing diffuse invasion and replacement of normal tissue by the squamous carcinoma with extension into the thyroid (left side).

and sixth decades—with the average age being sixty-five years. There is a strong preponderance of males over females with various statistics ranging from 5:1 to 10:1. It is about one-fourth as common as gastric carcinoma.

The lesions usually occur in the lower two-thirds of the esophagus with only 10 to 20 per cent arising in the upper third. Approximately 50 to 80 per cent of the tumors are of the squamous cell type. The rest are adenocarci-

nomas which have their origin in mucous or gastric glands. This factor has led many to believe that some of these tumors might actually be primary in the stomach. Most of these neoplasms produce stenosis and eventual occlusion of the esophageal lumen.

Carcinoma of the esophagus tends to spread predominately by direct invasion. However, three-fourths of the cases do show late metastases to lymph nodes but only 5 per cent of these have palpable nodes in accessible areas. The site of the metastases depends on the location of the primary tumor. Lesions of the lower two-thirds tend to go to the para-esophageal and hilar lymph nodes. Those of the upper third of the esophagus tend to spread to superior mediastinal and cervical nodes.

The tumor usually begins as a small grayish mucosal plaque which progresses in size and extends along the long axis of the esophagus. The mucosal surface usually ulcerates and develops into a fungating, necrotic lesion which extends throughout the wall of the esophagus and adjacent structures.

The diagnosis is established on the basis of the fairly typical history plus confirmation by x-rays, esophagoscopy with direct biopsy, and exfoliative cytology. The most characteristic symptoms are progressive dysphagia and regurgitation following eating. The diet of these patients progressively becomes more and more liquid in nature. X-ray findings are usually

diagnostic in three-fourths of the cases, especially the stenotic type. In the questionable cases, esophagoscopy with direct biopsy is indicated. Exfoliative cytology is becoming more and more accurate and is up to 70 per cent diagnostic in the hands of experienced observers.

After the appearance of symptoms, untreated esophageal carcinoma is rapidly fatal with the average life expectancy ranging from seven to twelve months. Intensive deep radiation therapy, at best, appears to be only a palliative method. Thirty per cent five-year cures have been reported in selected cases following major surgical intervention. However, including these, the overall five-year cure rate for all cases of esophageal carcinomas is still a disappointing 0 to 7 per cent.

SUMMARY

An interesting case of carcinoma of the esophagus is presented with a description of the postmortem findings. Following this, there is a discussion of the subject of esophageal carcinomas.

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Cholesterol Alterations With DNA

Single injections of heterologous deoxyribonucleic acid (DNA) can produce prolonged reductions of serum cholesterol in rabbits. Within six months after administration of 1 mg. of highly purified, undenatured DNA prepared from beef liver, mean serum cholesterol values for 20 rabbits declined 35% and remained low during the remainder of the two-year observation period. Decline in cholesterol

values was most pronounced in rabbits with high normal preinjection concentrations. Injections produced similar alterations in serum phospholipids but had no effect on serum neutral fat. In additional animals, the time required to effect changes varied inversely with the amount of DNA administered.—J. PHILIP SAVITSKY, M.D., *Am. J. Physiol.*, 200:541-544, 1961. Abstracted in *Modern Medicine*, 1961.

Criteria for Design of the Mercury Environmental Control System, Method of Operation and Results of Manned System Operation

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PROJECT MERCURY, under the direction of the National Aeronautics and Space Administration, is the United States' effort to place a man in orbital space flight. The major requirements for the program include the Army Redstone and the Air Force Atlas boosters, the McDonnell Capsule—the payload, and the ground complex which includes the pad operation, tracking stations and recovery system.

The announced objectives of the project are to: (1) place a manned space capsule in orbital flight around the earth, (2) investigate man's performance capabilities in a true space environment, and (3) recover the capsule and man safely.

Man will be launched into an orbit around the earth in the not-too-distant future. In order to accomplish this scientific feat, it is necessary to provide the astronaut with a controllable environment that satisfies his physiologic tolerances. The object of this paper is to outline the criteria for the design of the life support system, describe the operation of the McDonnell system for the Project Mercury capsule, and give results of manned operation at simulated altitudes.

In the development of the environmental system, simplicity of design was a very important consideration, primarily because of reliability requirements and also because of critical delivery requirements. In view of these requirements, a decision to use an artificial atmosphere composed

of essentially 100 per cent oxygen rather than a more complex mixed gas system was made early in the program.

Due to the O₂ environment in which man has always lived, his evolutionary processes have adapted him well to our atmospheric concentration. Man can tolerate some deviation from his natural environment and research has attempted to demonstrate these limits.

It has been established that if a man is to breathe 100 per cent oxygen, his limits would be between 16,000 (412 mm. Hg) and 38,000 feet (155 mm. Hg) altitude depending upon the individual. The suitability of high oxygen concentrations at lower altitude has not been well established for extended periods of time. Since these are tolerances depending to a great extent upon individual differences for conservative operational purposes, we must reduce the range to limits which are approximately 20,000 (349 mm. Hg) to 33,000 (196 mm. Hg) feet altitude. This already narrows the possible pressure down to a 3 psi range.

The total pressure required to keep most flight crew people out of the "bends"-susceptible altitude for at least up to a day is approximately 27,000 feet (258 mm. Hg). We are now in a range between 20,000 and 27,000 feet.

Fire hazard becomes a more important consideration as the concentration of oxygen increases. The desire here would be to have as low a total pressure as possible. Since the minimum pressure desirable for the man is 258 mm. Hg or 27,000 feet, it was selected as the final capsule total pressure.

This reduced pressure is very desirable because it avoids a high structural weight penalty for the capsule as well as minimizing leakage

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rates. The leakage rate becomes a very important item when replacement is from a stored supply.

The only problem made more difficult by the reduced pressure is removing heat from the man and equipment.

The task of assigning a realistic average body heat production for a twenty-eight-hour flight received considerable attention. The astronaut's metabolic rate during the mission is the real key for determining the quantity of supplies to be stored on board. Once one assigns a value to metabolic rate, then the design figure for the oxygen supply volume, carbon dioxide absorber size, coolant material supply, and requirements for drinking water and food can be established. Because of all these accumulating factors, the importance, weight wise, of assigning a realistic figure is obvious. From past experience of measuring men during simulated flights in a pressure suit, both pressurized and unpressurized, and considering the restriction to movements within the capsule, it was concluded that an average 400 BTU/hour (100 kg. Cal./hr.) would be the design figure. In order to produce this much heat per hour, it will take 345 ml./min. STP of oxygen or 1.825 pounds per twenty-eight-hour flight time. This assumes a respiration quotient (R.Q.) of 0.82 which can vary. We compensate for leakage by adding oxygen and our design assumes a leakage rate of 300 ml./min. STP. The oxygen supply bottle is designed to hold 4 pounds which provides an additional 155 ml./min. margin for leakage and/or oxygen consumption. When man uses oxygen at the rate of 345 ml./min. STP with an R.Q. of 0.82, he must be producing CO_2 at the rate of 283 ml./min. STP. In designing the CO_2 absorber, we sized it for a 400 ml./min. CO_2 production.

Lithium hydroxide is used to consume the CO_2 because of the excellent absorption ratio. An efficiency of 75 per cent was used in calculating the required quantity. A laboratory test was run on the canister in which 400 ml./min. STP of CO_2 and 2.27 grams H_2O /min. was added to the system. The partial pressure

level of CO_2 was maintained below 2 mm. Hg for over thirty hours and it required thirty-six hours to reach the 8 mm. Hg partial pressure level which was the upper design level.

The heat within the capsule is removed from the system by evaporating water which has the best heat of evaporation vs. weight ratio of any conveniently available liquid. The cabin or suit temperature is conveniently controlled by manually varying the rates of water flow into the respective heat exchangers. Since the vapor pressure of water at comfortable environmental temperatures are such that boiling does not occur below approximately 100,000 feet, depending on the temperature, water is not suitable for cooling below this altitude. The flight time below 100,000 feet is very short and the thermal inertia of the system will maintain the temperature within safe limits.

The humidity is not controlled independently of temperature in the suit system. As the temperature is reduced in the heat exchanger, the water is condensed into droplets. A sponge downstream of the heat exchanger removes the liquid water. At this temperature, the gas is saturated. The greatest temperature rise is in the suit and, even though the man is adding water to the gas, the relative humidity is decreasing. The gas will leave the suit at a lower relative humidity than when it entered.

The system will operate under one "g", increased "g's", and in a weightless condition. Much consideration has been given to a system design in which a catastrophic failure could not occur from the failure of a single component. At the same time it was necessary to keep the design as simple as possible.

The astronaut, wearing his pressure suit, enters the capsule approximately two hours before launch time. The suit is connected to the environmental control system by flexible hoses connected at the waist and helmet. The helmet visor is closed and the system is purged with 100 per cent oxygen until the suit system contains nearly 100 per cent oxygen. At this same time, the suit and cabin system fans are started and freon is passed through the water side of

ENVIRONMENTAL CONTROL SYSTEM—GREIDER AND BARTON

the suit and cabin system heat exchangers for cooling during the pre-launch period. The freon flow is controlled to maintain the desired temperature and continues until the umbilical is

tilation ducts to distribute the gas over the astronaut's body for convective and evaporative cooling. The flow returns over his body to the helmet where part of the gas is used for breath-

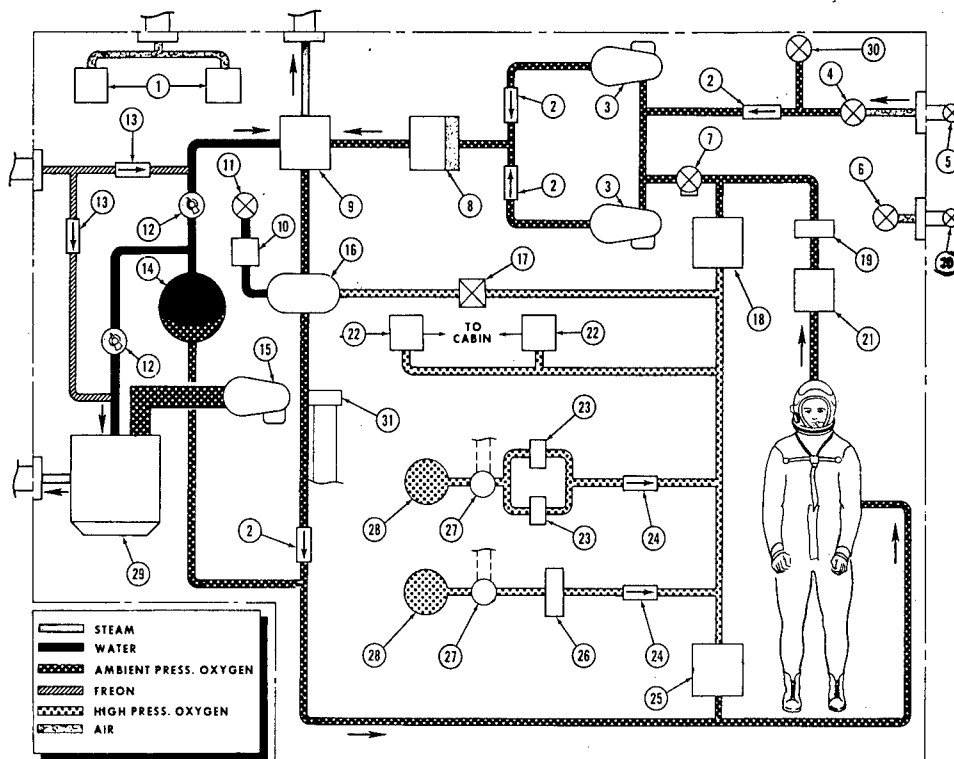


Fig. 1. Mercury Environmental Control System: (1) Cabin press relief and emergency decompression valve, (2) Oxygen check valve, (3) Suit circuit blower, (4) Inlet air valve, (5) Snorkel inflow valve, (6) Post-landing outflow valve, (7) System S/O emergency valve, (8) Suit CO₂ absorber and odor control, (9) Suit circuit heat exchanger, (10) Condensate tank, (11) Condensate removal valve, (12) Comfort control valve, (13) Freon 114 check valve, (14) Cooling water tank, (15) Equipment blower, (16) Suit circuit water absorber, (17) Solenoid switch valve, (18) Suit pressure regulator, (19) Suit pressure relief valve, (20) Snorkel outflow valve, (21) Solids trap, (22) Dual cabin pressure regulator and repressurization valve, (23) Oxygen press reducer, (24) Oxygen check valve, (25) Emergency oxygen rate suit valve, (26) Oxygen pressure reducer, (27) Oxygen pressure transducer, (28) Oxygen bottle, (29) Cabin equipment heat exchanger, (30) Ground oxygen inlet valve, (31) Carbon dioxide sensor.

separated before launch. After the entrance hatch is closed the cabin is purged with 100 per cent oxygen. From this time until his return to 20,000 feet, the astronaut is separated from the earth's ecologic system.

The suit system operates by the following method (Fig. 1): The gas enters the pressure suit at the waist and flows through the suit ven-

ing purposes. The gas then leaves the helmet and passes through a solids trap (21), goes by an over pressurization relief valve (19), through a system shutoff valve (7), and through one of two compressors (3) which increases the pressure approximately 10 inches water. The gas is then directed through the canister (8) which contains charcoal to absorb noxious odors, and

lithium hydroxide to absorb CO_2 . The CO_2 absorption is an exothermic reaction and as such adds to the system approximately 136 BTU/hr. depending on the quantity of CO_2 absorbed. The gas enters the heat exchanger (9) and the temperature is dropped to the astronaut's selected temperature . . . normally around 45°F. Since the condensed water is in a weightless state, the gas must be passed through a separator (16), which in this case is a sponge. The sponge is sized to hold all water the man might produce in thirty minutes at which time the water is squeezed from the sponge and collected in a tank (10). The gas at this reduced temperature (but near a saturated condition) is returned to the suit. This is the normal mode of operation for pre-launch and all phases of the flight until the return to 20,000 feet.

During the countdown period, the suit system works just as in orbit—the CO_2 is being absorbed, oxygen is replaced by the demand regulator (18), and the water is condensed in the heat exchanger and then removed by the sponge.

Upon launch, the pressure in the capsule and suit systems approximately follows ambient pressure until 25,000 feet is reached, at which time the cabin pressure relief valves (1) close to hold this pressure and remain closed until the capsule returns to 25,000 feet.

From launch to around 100,000 feet, depending on the internal temperature, there will be no cooling taking place in the heat exchangers. From 100,000 feet altitude until return to this altitude, the systems will be cooled by evaporating water in the heat exchanger and exhausting the vapor into space. The capsule pressure is maintained by adding O_2 as demanded by either of the two cabin pressure regulators (22). When operating with a closed suit circuit, the oxygen which the man uses is replaced, as demanded, by the pressure suit regulator (18) which has a demand function in addition to pressure regulation.

The oxygen supply consists of two bottles (28) containing four pounds of gaseous oxygen each at 7,500 psi pressure. The main supply has

enough oxygen for an eighteen-orbit flight. The system has two reducers (23) for redundancy both of which are set to deliver oxygen at 100 psi. The emergency system is controlled by a separate reducer (26) set at 80 psi. This means the main bottle must be used first even in an emergency. Two fans are provided on the suit circuit either of which has the capacity to provide adequate ventilating flow. A pressure switch is provided to turn on the second fan if the first should fail.

The water is supplied to the heat exchangers through manually controlled needle valves (12) from a water supply. Water is stored in a bladder container (14) with gas pressure on one side to insure positive operation under weightless conditions.

During launch, the astronaut will have his pressure suit helmet visor closed. The system is so designed that he can fly with the visor opened or closed in orbit. The visor must be closed manually if decompression occurs in the capsule. Most likely the astronaut will perform the complete mission with the visor closed except to eat or drink. Upon decompression if the visor is closed the astronaut will only notice the stiffening of the pressure suit. The suit system continues to operate exactly the same. Now the concern is for the leakage rate of the suit and environmental control system instead of the capsule wall. If the astronaut elects to continue his mission rather than abort, the leakage rate of the suit system must not exceed the capsule design figure. During decompression the cabin pressure control valves are automatically turned off when the pressure drops below 4 psi. Otherwise these valves would dump the total remaining oxygen supply.

If there is a leak in the environmental section of the suit system and the pressure drops to 3.5 psi, the major part of the system will be blocked off [system shutoff valve (7) and the check valve upstream from the suit] and the emergency constant flow valve (25) will deliver 0.05 lb./min. of oxygen for eighty minutes plus what remains in the normal bottle. This valve can be operated manually if the CO_2 rises to a

dangerous level or if the fans stop. This constant flow must then supply the man with his breathing oxygen as well as remove his body heat for the remaining orbital time plus the re-entry time. This has been accomplished in a simulated flight and works satisfactorily.

On re-entry there is no change in the normal system until the capsule has descended to approximately 100,000 feet, depending on the temperature, at which time the water for cooling the heat exchanger stops boiling off. Upon reaching 25,000 feet the cabin pressure relief valves open and the capsule pressure increases with the ambient pressure. At 20,000 feet, the snorkel valves (4 and 6) open and air is pulled into the suit system over the astronaut and dumped into the capsule either through the visor opening if open or through the suit pressure regulator (18). This method of ventilation continues into the post landing condition and can be maintained for twelve hours or longer depending on the power supply. Survival equipment, including a raft, is available if the need or desire to leave the capsule arises. Food and water are provided for body needs as well as for experimentation in handling.

Instrumentation on the astronaut includes two electrocardiographic leads, respiration rate, and deep body temperature. Voice communication is also considered significant from the standpoint of determining the well being of the astronaut. Important environmental measurements are total pressure and oxygen partial pressure in the system.

Manned System Testing.—The test vessel consists of a steel capsule with a production environmental control system. The altitude chamber is controlled to an altitude of 30,000 feet except during the check of the automatic operation of the emergency oxygen rate valve at

which time it is controlled to 34,000 feet. The water side of the heat exchanger is maintained below 2 mm. Hg.

Approximately 100 hours manned system testing at altitude was accomplished. These tests utilized five subjects with the longest period at altitude [5 psi 95 per cent pO_2 (oxygen-combining potential)] being twenty-eight hours. The nominal test time was four and one-half hours. A particularly severe test was conducted to simulate four and one-half hours of orbit followed by twelve hours of the post landing phase with ambient conditions of 85°F. and 85 per cent relative humidity. Various modes of system operation were demonstrated and consisted of normal and emergency operation of the suit circuit with the cabin decompressed. The heat pulse during re-entry was simulated for each of these modes.

Physiologic measurements identical to those in the basic capsule were made during the test runs. The pO_2 and pCO_2 were measured by a Beckmann Analyzer, and in addition, gas samples were taken for comparative analyses. The system provided adequate ventilation and temperature-humidity combinations to maintain the comfort level of the occupant during all phases of the tests at altitude. No adverse physiological effects occurred. In the simulated post landing phase, the subject started with a pulse of 60 and a deep body temperature of 98.2°F. and ended the twelve-hour period with a pulse of 110 and a deep body temperature of 101°F.

It is significant to note that during these closed system tests, the pCO_2 was maintained below 1 mm. Hg at all times and the pO_2 stabilized at values between 92 and 95 per cent depending on suit inlet temperature. The variation in pO_2 is primarily caused by the difference in pH_2O vapor.

Accuracy of Lever-Displacement Behavior of Rats following Exposure to Accelerations

ROBERT M. HERRICK, PH.D.

MANY STUDIES have been conducted to evaluate the effects of exposure to acceleration on the physiological systems of animals. Relatively few experiments²⁻⁵ have been performed, however, to evaluate quantitatively, the effects of exposure to acceleration on the subsequent behavior of animals. The present experiment was undertaken to help fill this need. Specifically, the experiment was designed to determine how well animals can perform a finely-coordinated movement following exposure to positive G. The movement consisted of depressing a response lever handle through an arc of at least 23.62 degrees but not greater than 28.76 degrees, and then releasing the lever handle.

MATERIALS AND METHOD

Six male albino rats of Sprague-Dawley strain served as subjects. Two of the rats were used as control animals and four as experimental animals. All were approximately 200 days old on the first pre-G control day.

Two types of equipment were used: (a) apparatus for establishing and testing the behavior of the rats, and (b) apparatus for restraining and centrifuging the rats, and for monitoring their heart rate during centrifugation.

The compartment in which the behavior of each rat was established and tested was 8 in. wide, 9 1/8 inches long and 7 5/8 inches high. A filled food container (Purina Laboratory Chow) was mounted on one wall of the compartment.

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Opinions or conclusions contained in this report are those of the author. They are not to be construed as necessarily reflecting the views or the endorsement of the Navy Department.

On the opposite wall the response lever was mounted. The T-bar handle of the lever was located at 2-7/16 inches above the floor of the compartment at an angle of 23 degrees above the horizontal. Water rewards were delivered by means of a tiny cup which projected 1/4 inch above the floor at a point 2 inches to the side of the lever arm and 5/8 inch from the wall. Two small indicator lights were mounted on the wall above the response lever.

The response lever is described in detail elsewhere.¹ The characteristics which are relevant to this report are presented here.

On one side of the fulcrum the lever arm terminated in the form of a horizontal metal rod (T-bar), 1-3/16 inches long and 5/16 inch in diameter. On the other side of the fulcrum, the lever arm carried an electrical brush. When the T-bar was pressed by the rat the brush wiped, in order, a series of electrical contacts flush-mounted in a commutator plate. By means of the brush-commutator plate system, the distance the T-bar moved as a result of each lever-press was classified into intervals or "positions." The "home" position represented the arc of the T-bar between its resting place and 3.30 degrees. Position 1 represented, approximately, the next 5.08 degrees of arc of the T-bar, i.e., the interval between 3.30 degrees and 8.38 degrees. Each successive position (Positions 2 through 8) also represented approximately 5.08 degrees of arc. Since the T-bar was 5.08 cm. from its fulcrum, each 5.08 degree arc represented approximately 0.45 cm. of arc. A force of 26,500 dynes was required to depress the lever. The force required remained constant, within 1 or 2 per cent, throughout the total 43.94 degrees excursion of the T-bar. Accessory equipment used included automatic programming and recording devices.

EXPOSURE TO ACCELERATIONS—HERRICK

Restraint and centrifugation. The restraint consisted of a wire mesh cylinder which was wrapped around the rat and taped in place. The cylinder fitted snugly into a metal capsule which was mounted on the arm of a centrifuge. The capsule was mounted so that the rat was lying on its ventral side with its body parallel to the centrifuge arm and its nose facing the center of rotation of the centrifuge arm.

The G values used were calculated on the basis of the relation $G = \frac{\omega^2 R}{32.2}$, with R taken as the distance from the center of rotation to the rat's heart, viz., 7.17 feet.

Immediately preceding exposure to centrifugation, and during exposure to centrifugation, the heart rate of each experimental rat was recorded, using a technique and equipment developed by Sipple and Polis.⁶ The principal purpose for monitoring the heart rate was to provide an objective means for aborting a centrifuge run if the rat appeared to be dying.

The rats were trained to depress the T-bar of the lever an exact distance. Then, the lever-pressing behavior was evaluated immediately following exposure to positive G.

Phase I: Lever-press training. Following preliminary training, the rats were trained in the final lever-pressing task. The daily procedure used to establish and test performance on the final task was as follows. After being deprived of water for 22½ hours, a rat was given a one-hour period in the test box. The task of the rat was to press the T-bar of the lever to Lever Position 5, i.e., through an arc of at least 23.62 degrees but not greater than 28.70 degrees* and then release the T-bar. For this, the rat received a 0.014 cc cup of water immediately after the T-bar returned to its home position. If the lever press resulted in a maximum displacement of less than 23.62 degrees or greater than 28.70

degrees, the rat was not rewarded. At the end of the hour in the test box the rat was returned to its cage and, fifteen minutes later, given free access to water for fifteen minutes. Food was always available to the rat in the cage and in the test box.

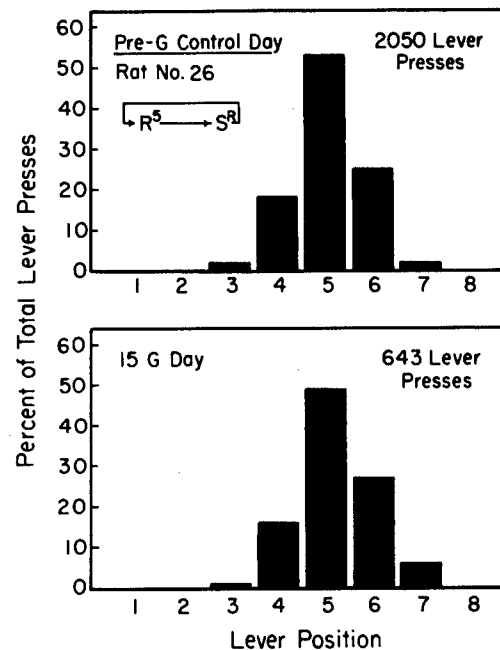


Fig. 1. Percentage of lever presses made to each lever position by a typical rat during a one-hour test period on a control day and on a day immediately following five minutes exposure to 15 G positive.

The last three days of Phase I are referred to as the Pre-G control days.

Phase II: Exposure to centrifugation. In this phase the procedure of Phase I continued. In addition, the rats were centrifuged just before they entered the test box. The procedure was as follows. At the centrifuge site the electrodes were clipped, dorsally and ventrally, into the rat. The rat was placed in the restraint and capsule. After ten minutes rest in the capsule, the centrifugation period, which lasted five minutes, began. Five minutes after the end of the centrifugation period, the rat entered the test box to begin its one hour lever-pressing period.

*The mean value of 5.08 degrees for each position, other than the home position, was used to calculate the limits of Position 5. The actual limits of Position 5, based upon calibrations, were 23.62 degrees and 28.76 degrees.

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On the first day of this phase (and, for the control rats, on all days of this phase) the above procedure was followed, but the rat was placed

exposed to 2 G; on the third day, to 5 G; on the fourth day, to 10 G; on the fifth, to 15 G; and, on the sixth, to 20 G.

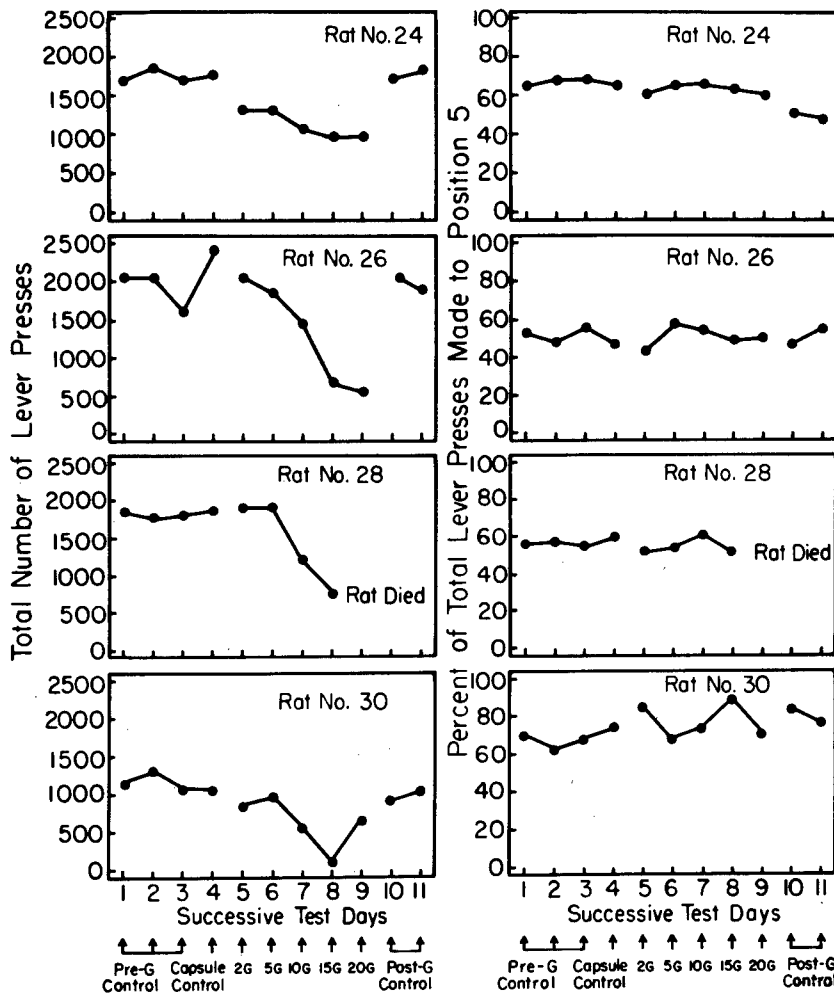


Fig. 2. Effects of five minutes exposure to positive G on the number of lever-presses and on the accuracy of lever displacement. The 20 G exposure of Rat No. 30 was terminated after only 100 seconds. Rat No. 28 died during the 20 G exposure.

in a capsule on the floor of the centrifuge room, rather than in the capsule on the centrifuge arm. Thus, the rat was exposed to the insertion and removal of the electrodes, to the restraint, to the sound of the centrifuge operation, etc., but it was not centrifuged. This day is referred to as the *capsule control* day.

On the second day of this phase the rat was

Phase III: During the two days (*post-G* control days) following the exposure to 20 G, the rats received the same treatment as that of Phase I.

RESULTS

Figure 1 is a sample record presented (a) to acquaint the reader with the method used to

EXPOSURE TO ACCELERATIONS—HERRICK

summarize the data and (b) to illustrate the typical effect of exposure to high positive G on the behavior under consideration.** The figure indicates that, although the total number of lever-presses decreased greatly as a result of exposure to G (2050 versus 643), the percentage of presses to Position 5, the "rewarded" position, remained well within the normal day-to-day variation. Moreover, the percentage of lever-presses to each of the other positions remained quite constant.

Distributions similar to those of Figure 1

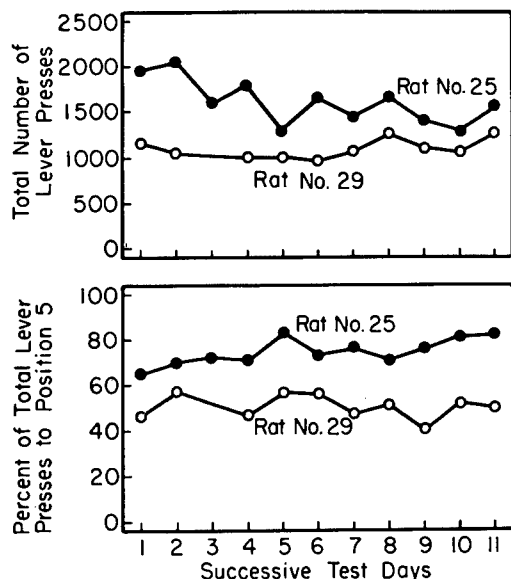


Fig. 3. Total number of lever-presses and accuracy of lever displacement for two control rats. On the fifth day, Rat No. 25 was accidentally treated as an experimental rat and exposed to 2 G. Rat No. 25 was not tested on the third day.

were plotted for all the rats for all the experimental days and show the same relationship, viz., exposure to high positive G decreases the total number of lever-presses, but has no significant effect on the percentage of presses made to each lever position.

**Since the rats were exposed to successively higher G levels on successive days the behavior on a given day following centrifugation may reflect the cumulative effects of the exposures, rather than the effects of a single exposure. This qualification applies to all the results reported in this paper.

Summary data for each of the four experimental rats are presented in Figure 2 and a few additional observations are noted. The first is that exposure to the lower G levels did not, in

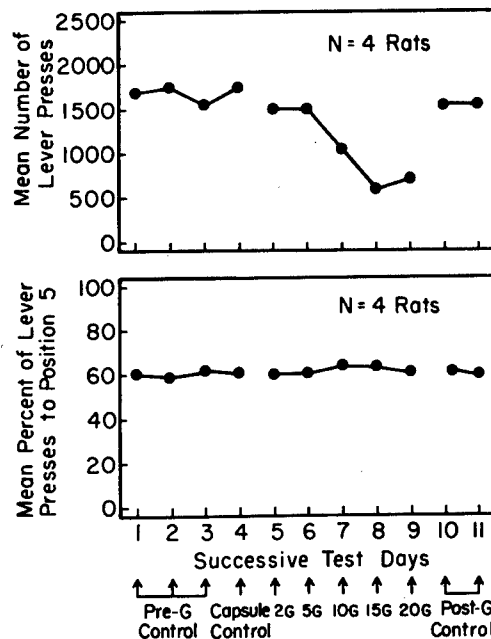


Fig. 4. Effects of five-minute exposure to positive G on subsequent lever-pressing behavior of rats. One rat died during exposure to 20 G; therefore, the last three experimental points in each plot represent the data of three rats.

general, result in a decrease in the total number of lever-presses. Secondly, on the post-G control days, the total number of lever-presses returned to the former, pre-G, value.

Figure 3 presents data for the two control rats. Figure 4 shows a summary of data contained in Figure 2.

Figure 5 shows a cumulative record of presses to Lever Position 5 related to time. It can be seen that the number of presses to Lever Position 5 following exposure to 15 or 20 G was lower than the number during the control period for two reasons: (a) the rat made no presses to Position 5 during the initial period in the test box, and (b) when the rat began pressing to Position 5, it did so at a lower rate. Periodic counter readings indicated that the

EXPOSURE TO ACCELERATIONS—HERRICK

curves in Figure 5 may be taken as indices of the total lever-pressing rate. Thus, during the initial period when the rat made no presses to Position 5, it made no presses to any other

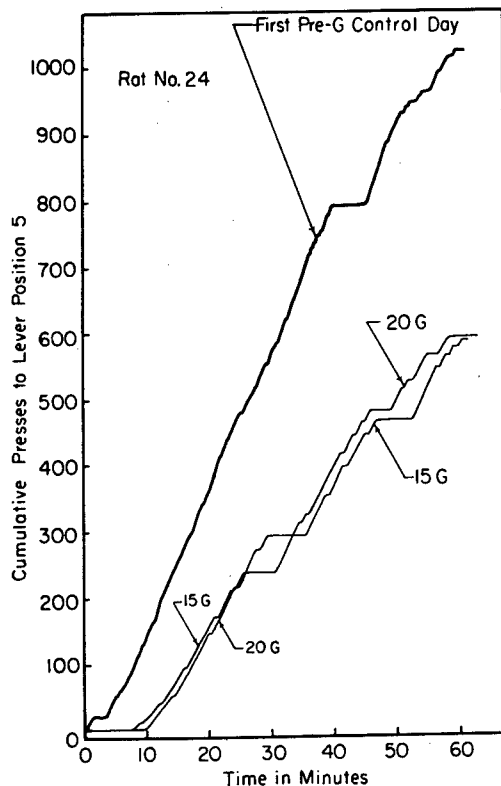


Fig. 5. Cumulative presses to Lever Position 5 during one-hour test period on a control day, and on days on which the rat underwent five minutes exposure to 15 G positive and to 20 G positive immediately preceding entry into the test box.

position. During the period of pressing to Position 5 at a lowered rate, the overall lever pressing rate was reduced. All four experimental rats exhibited the same type of behavior following exposure to 15 G and to 20 G.

DISCUSSION

The results of this study are similar to those of a discrimination experiment previously reported.³ In the discrimination experiment, rats were trained to press a response lever in the presence of a light and to refrain from pressing it in the absence of the light. This behavior

was evaluated following each of several exposures to successively higher negative Gs. The experiment demonstrated that, although the lever-pressing rates were lowered, the rats were able to exhibit discriminative behavior following every exposure below their lethal G levels.

The results also agree with those reported by Oakes and Hollis.⁵ These investigators found a decrease in lever-pressing immediately following thirty minutes' exposure and immediately following three hours' exposure to 4.1 positive G.

SUMMARY

Rats were trained to press a T-bar handle of a response lever through an arc of at least 23.62 degrees but no greater than 28.76 degrees (Lever Position 5). This behavior was then evaluated immediately following five minutes exposure to each of the following positive G values: 2, 5, 10, 15, 20. The behavior was not influenced at the lower G values. At the higher G values, the lever-pressing rate decreased, but the percentage of lever presses made to Position 5 remained the same.

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Effects of Pressure Suit Inflation on Reaction Times of Project Mercury Astronauts

NEAL M. BURNS, PH.D. and R. L. BURDICK, CDR, MC, USN

THE SUBJECT MATTER of this paper is properly concerned with a sub-area of bioastronautics, which may be called biomechanics. Specifically, we were interested in obtaining

of the suit. Accordingly, the following experiment was designed in the interest of accuracy and to avoid wasting potentially valuable information.

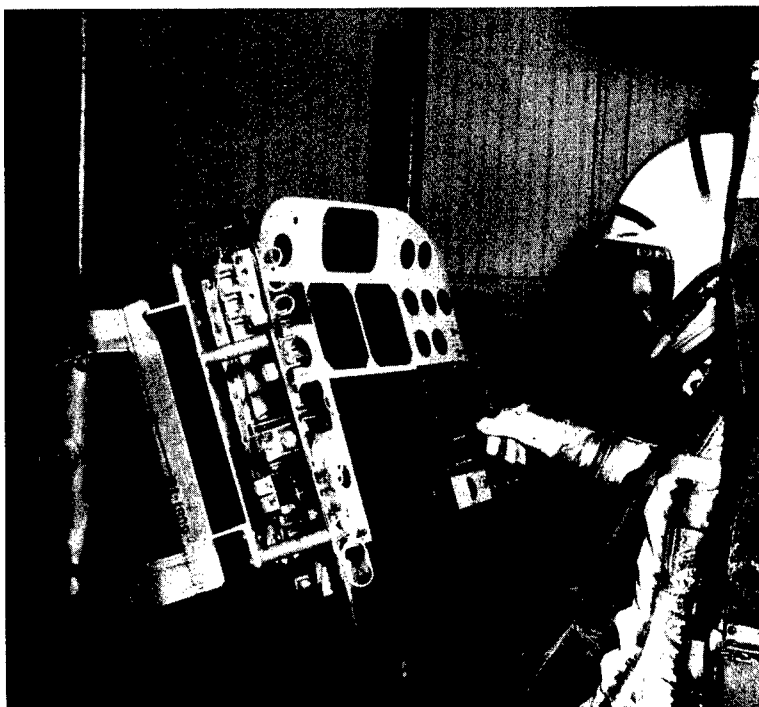


Fig. 1. Mercury panel installation at the Air Crew Equipment Laboratory.

estimates of performance from the Project Mercury astronauts while they were wearing the Mercury full pressure suit and working on an intermediate mock-up of the Mercury capsule panel. It was considered mandatory to assure proper fit of the individual astronaut's suit and to begin familiarizing him with the use

MATERIALS AND METHODS

Subjects:—The subjects participating in this study were all well qualified test pilots and astronaut nominees in the Project Mercury program. Six of the seven astronauts served as subjects in most of the procedures described below.

Apparatus:—Figure 1 shows the mock-up of the Mercury panel installed at ACEL. A

From the Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pennsylvania.

realistic stimulus array was fabricated from McDonnell Aircraft Corporation specifications with all the controls, switches, and lights on the panel in operating condition. The attitude con-

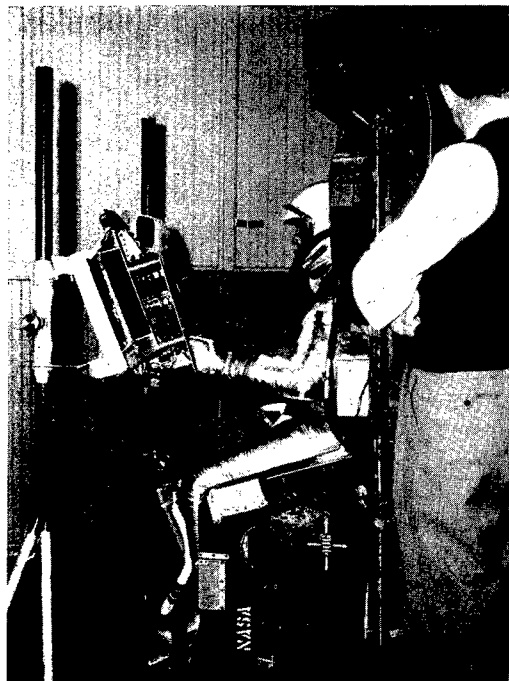


Fig. 2. Mercury panel with operator at 0 psi.

trol was not included because of the particular complexity that function entails. Instead, two conventional flight control sticks were modified and integrated into the task. One control stick was mounted near the arm rest on each side of the couch support on a sliding bracket.

A reaction time device was constructed such that signals, in the form of ongoing indicator lights, could be presented to the subject. Any number of stimuli from one to twelve could be presented simultaneously, requiring him to respond by actuating the appropriate switches or controls. The timing device allowed two aspects of the subject's response to be measured: latency, or that period between the presentation of a signal and the beginning of subject's hand movement, and reaction time, which was the period between initiation and completion of the response or response sequence.

In order to facilitate this distinction and the general testing procedure, the subject was required to return his hands to the control sticks and to depress the armaments control switch. This "home" position enabled the subject to receive the next stimulus presentation. The number of responses, the number of errors, the latency of response, and reaction time were recorded by the experimenter.

Procedure:—Each of six subjects was first tested with the suit at 0 psi, or more accurately, ventilation air pressure (Fig. 2). Approximately thirty-five minutes was required to finish this

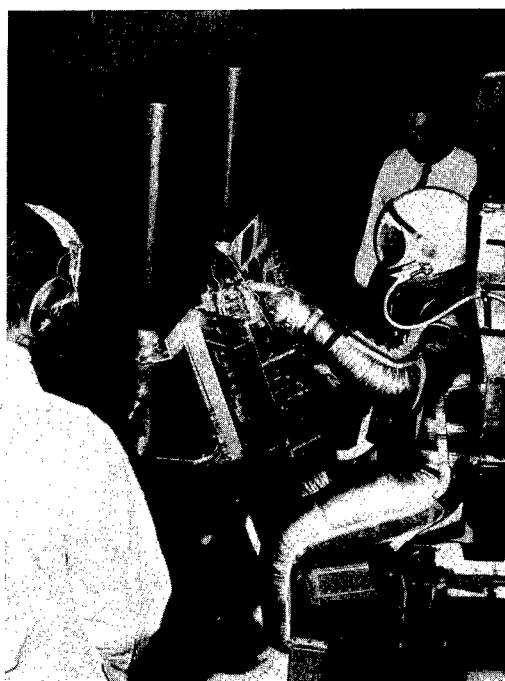


Fig. 3. Mercury panel with operator at 5 psi.

portion of the test. During that time each subject received twenty-five sequence stimuli involving groups of six switches or controls, and about fifty single stimuli involving only a simple response to one light. Ten minutes were allowed to elapse before the subject's suit was inflated for the 5 psi test. When the suit had been inflated to the desired pressure, as shown in Figure 3, and the flow of vent air adjusted, the

REACTION TIMES—BURNS AND BURDICK

second series of stimuli were presented. These were given in the same order as they were in the earlier 0 psi run. Two experimenters were always on hand, apart from the personnel

fact, could not be properly actuated, and at times even reached, by the astronaut wearing the inflated suit. This experimental fact must be assessed in the light of operational need to

TABLE I. MEAN REACTION TIME (RT) SCORES
FOR FOUR ASTRONAUTS

| Reaction Time for Single Response (Seconds) | | | Reaction Time for Response Sequence (Seconds) | | |
|---|------------------|------------------|---|------------------|------------------|
| Stimulus | 0 Psi | 5 Psi | Stimulus | 0 Psi | 5 Psi |
| 1 | 1.3 | 3.5 | A | 7.8 | 14.9 |
| 2 | 1.2 | 2.0 | B | 5.3 | 10.0 |
| 3 | 1.3 | 2.8 | C | 4.5 | 7.8 |
| 4 | 0.9 | 1.5 | D | 6.9 | 12.6 |
| 5 | 0.9 | 2.0 | E | 4.1 | 6.8 |
| 6 | 0.8 | 1.7 | F | 4.8 | 5.2 |
| 7 | 1.1 | 2.6 | G | 4.4 | 8.9 |
| 8 | 1.0 | 1.9 | H | 4.3 | 8.6 |
| 9 | 0.8 | 1.8 | I | 4.3 | 10.0 |
| | $\bar{X}_0=1.03$ | $\bar{X}_5=2.20$ | | $\bar{X}_0=5.16$ | $\bar{X}_5=9.42$ |

needed to handle inflation of the pressure suit. One experimenter recorded the latencies, reaction times, and errors, while the second programmed the stimuli and monitored the intercom.

RESULTS

The quantitative data presented use only the reaction time scores obtained from four astronauts. Changes in the prescribed routine created by other demands made some of the data incomparable. It must be emphasized that this work was done as a part of familiarization, and that these data were collected on either the first or the second occasion the subjects had worn this particular model of the pressure suit.

Table I shows the reaction times for both the single responses and the response sequences under the 0 psi and 5 psi conditions. (The latency measures were not subject to statistical analysis since it was obvious by inspection that this aspect of the response was not affected by suit pressurization.) The various stimulus arrays are numbered along the left. It is apparent and expected that reaction times for the 5 psi condition are greater than those for the 0 psi condition.¹ The difference between the means was significant ($p < .01$) using the Wilcoxon Signed-Rank test. Certain controls, in

determine whether the finding has any operational significance.

Another consideration is the possibility of inadvertent actuations occurring under the 5 psi condition. A cumulative recorder indicated the slope (i.e., rate of response), correct responses, and errors (or inadvertent actuations). While the astronauts typically did not make errors under the 0 psi condition, four to six inadvertent actuations were frequently made under the 5 psi condition. It is interesting, also, to note that these errors were truly inadvertent; the astronaut was notified of a wrong response by the monitoring illumination of the "abort" light on the panel—this never failed to surprise the subject, since he was unaware that he had committed an error. Frequently, the inadvertent actuation involved contact with adjacent toggle switches, some of which were supposedly protected with lucite guards.

Let it be noted that operationally the Mercury console is typically a one response device; the multiple response data were included for experimental completeness.

DISCUSSION

Basically, both the pressure suit configuration and the Mercury panel reflect sound research

and development design. Thus, this brief report does not necessarily mean that changes in either area are prescribed. Some of our other research, for example, has shown that properly motivated subjects can learn, with repeated testings, the alternative postural adjustments and motor movements required for effective pressure suit mobility.¹ In almost every instance, speed and accuracy of movement in the 5 psi condition have been reduced to the normal operating range.

The differences in reaction time reported in the present study represent statistically significant differences. The operational significance of these differences remains to be assessed by comparison with the mission profile. Assuming, however, that rapid and accurate movements will be part of any particular performance in the capsule makes us believe that the findings reported herein deserve operational consideration.

First, the possibility of repeated training reducing the 5 psi reaction time and number of errors should be investigated further. (It is again noted that this was essentially a first experience for these subjects). At the moment, it would appear that six hours of 5 psi training on the final capsule panel would be helpful. Secondly, the use of locking toggle-switches instead of lucite guards should be considered in order to minimize the probability of inadvertent actuation. Thirdly, the assignment of control locations in *all* space craft should be made on the basis of a realistic compromise among such factors as mechanical limitations, anthropometry ranges and actuation need with an inflated pres-

sure suit. The suit has been constructed such that if a well-planned cockpit and panel layout is designed, its controls should easily be reached by the pressure-suited operator.

Another consideration concerns the true measurement of performance efficiency of pressure-suited operators. The amount of work expended or physiologic output must be measured simultaneously with motor performance. It was observed, for example, using some of the astronaut population, that heart rate increased from 66 beats per minute under the 0 psi condition to 80 beats per minute under the 5 psi condition while the operator worked on identical task profiles. Thus, the amount of effort expended by an astronaut in an inflated pressure suit in order to attain performance values similar to those obtained in the uninflated condition may be considerable—particularly so when long periods of time are involved and other stressors (e.g., excessive heat, acceleration) are involved.

SUMMARY

The reaction times of the Project Mercury astronauts were tested under two conditions of pressure suit inflation: 0 psi and 5 psi. Under the 5 psi condition, reaction times increased significantly as did the frequency of inadvertent actuation.

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Longevity in the U.S.S.R.

In Britain 0.3 per 100,000 of the population may confidently expect to top their century. In the Soviet Union, however, the chances of becoming a centenarian are at least thirty times as great according to a recent report, whilst in some parts of the Union, such as Azerbaijan, with its

84 centenarians per 100,000, the chances improve more than 250 per cent. The census upon which this is based shows that there are 21,708 centenarians in the U.S.S.R., 592 of whom are "at least over 120."—From *The Practitioner*, 1961.

Hearing Conservation Program as Conducted Within the Second U. S. Marine Corps Aircraft Wing

CAPTAIN RUSSELL G. WITWER, MC, USN and
LIEUTENANT (JG) C. C. COLE, SR., MSC, USN

MUCH has been written on the subject of ever-increasing noise problems and the resulting hearing loss sustained by aviation personnel. A large proportion of these articles are couched in terms which are mysterious to the average medical officer, and most confusing to the layman.

Justified concern was manifest upon completion of over 9000 audiograms at the Marine Corps Air Station, Cherry Point, North Carolina, using the Rudmose Automatic Audiometer and sound-proof booth for testing, individual history taking, and the IBM filing system. Results revealed what to us was an alarmingly high percentage of hearing loss, with some cases bordering medical survey levels.

A hearing conservation program was recommended by the U. S. Navy Bureau of Medicine and Surgery⁴ whenever the noise sound pressure level reached 85 decibels (db) in any or all of the following octave bands measured in cycles per second (cps) 300-600, 600-1200, 1200-2400, and 2400-4800. This coincides in general with conditions that exist when it becomes difficult to hear a loud spoken voice at a distance of one foot. Hearing programs are mandatory where noise sound pressure levels reach 95 db.

The purpose of this study was to conduct noise evaluations, thereby delineating areas where ground crew members can work in safety without the use of sound attenuators, post dangerous areas, recommend procedures for military passengers and crew to follow in transport aircraft of high noise nuisance value, give protection against acoustic trauma wherever required, and explain our findings, using non-

medical terminology when possible, to Marine officers and enlisted personnel.

We were most fortunate in having fourteen different types of aircraft within the Air Wing for study, from the relatively quiet OE-2 (observation plane) through the various type transport aircraft, helicopters and high performance jets. The only available sound level meter (type 410 C, H. H. Scott, Inc.) has a range of 34 to 150 decibels, and was satisfactory for the purpose of this study. This meter measured the over-all intensity of sound as well as vibration acceleration, velocity, and displacement. The octave-band noise analyzer (type 1550-A, General Radio Company) was used to separate complex noises and sounds into bands of energy an octave wide in frequency. These measurements were taken because the human ear is not equally sensitive to all frequencies. They enable one to determine the frequency band which contributes most to total sound intensity.

METHOD

Sound and frequency levels were taken whenever possible within the immediate working area of the individual aircraft from the fuselage outward to 30 feet. Initial readings on fixed wing transports and helicopters were made at slightly above idle setting (1000 rpm). Sound levels were then recorded with the engines at 2200 revolutions per minute on ordinary power settings. Jet engine readings were measured at the test stand in percentage of full power beginning at 20, 50, 80, and 100 per cent with afterburner. The sound level meter was then moved away until readings of 95 db were obtained.

From the Marine Corps Air Station, Cherry Point, North Carolina.

HEARING CONSERVATION PROGRAM—WITWER AND COLE

Further recordings were made within the aircraft with the engine/s at idle, taxi, climb, cruise, full power, and hover in the case of helicopters. When available, measurements

At this point there is a drop in cps as reported by others.³

A differentiation of exposures to personnel during flight, within the pilot's compartment, and main troop space was conducted (Fig. 2). It can be readily noted that with the exception of the R5D, decibel levels far exceeded Bureau of Medicine and Surgery requirements for the use of protective devices. Previous studies in the HR2S helicopter⁵ revealed the over-all noise to be a potentially harmful level of 119 db in the troop compartment. The average hearing loss in

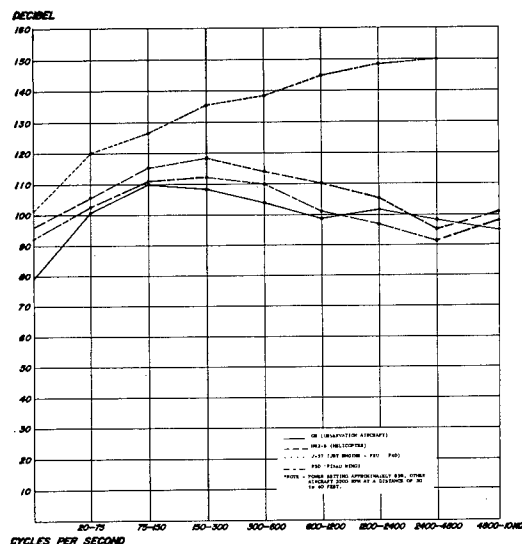


Fig. 1. A comparison of sound pressure levels and octave spread measurement of four basic type aircraft during test runs. Solid line represents OE (Observation Aircraft); dotted line, J-57 (Jet Engine—F8U and F4D); broken line with even spacing, HR2-S (Helicopter); broken line with uneven spacing, R5D (Fixed Wing). Power setting approximately 85 per cent, other aircraft 2200 RPM at a distance of 30 to 40 feet.

were taken in the pilot's bay, passenger compartment, fore, mid-ships, and aft. Additional tests were performed in the vicinity of generators, jet starters, hangars, and other working areas.

RESULTS

A comparison is shown (Fig. 1) ranging from the small OE single propeller observation plane to the most powerful noise generator available on location, the J-57 jet engine. Both the sound pressure and octave spread are recorded. From this graph one can see that propellers combined with internal combustion engines produce a flattened profile that follows a common pattern, while the jet engine climbs in decibel level and octave spread until at least 10,000 cps is reached.

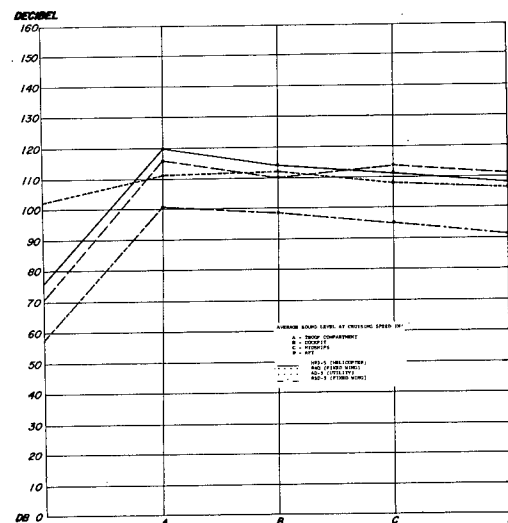


Fig. 2. Sound pressure level readings obtained during flight. Average sound level at cruising speed in: (A) troop compartment, (B) cockpit, (C) midships, and (D) aft. Solid line represents HR2-S (Helicopter); dotted line, AD-5 (Utility); broken line with even spacing, R4Q (Fixed Wing); broken line with uneven spacing, R5D-5 (Fixed Wing).

all frequencies following flights was found to be about 22 db when hearing protection was not worn. Almost all passengers complained of tinnitus for several hours following flight, and nearly one-third were subject to at least one other symptom such as nausea, headache, and drowsiness. This was also found to be true in the passenger compartment of the R4Q where the noise level was sustained at 112-114 db during flight.

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TABLE I. AVERAGE OCTAVE ANALYSIS AT APPROXIMATELY 40 FEET AND 45 DEGREE ANGLE CYCLES PER SECOND

| Type Aircraft | 20-75 | 75-150 | 150-300 | 300-600 | 600-1200 | 1200-2400 | 2400-4800 | 4800-10KC |
|--|---------|---------|---------|---------|----------|-----------|-----------|-----------|
| Helicopter HOK, HUS, HRS, HR2S | 102 db. | 108 db. | 104 db. | 110 db. | 104 db. | 100 db. | 96 db. | 92 db. |
| Transport R4D, R5D, R4Q | 104 | 106 | 108 | 106 | 104 | 102 | 100 | 94 |
| Jet engine at 80% power A4D, F8U, F4D, F9F8T | 110 | 114 | 116 | 120 | 122 | 120 | 118 | 116-118 |

These results indicate that frequencies of reciprocating engines including helicopters and fixed wing aircraft tend to produce problems in the 20-4800 cps range, while jet aircraft engines continue to reach and pass the sonic area.

An additional factor of fatigue was noted due to excessive vibration in these two types of transport aircraft. Just as technical efficiency is affected by prolonged exposure to noise, it must be assumed that the combat efficiency of troops would be affected by prolonged exposure to excessive noise and vibration.

It is of interest to note that crew members and mechanics working among helicopter type aircraft demonstrated very little hearing loss because of constant use of sound attenuators.

An average was calculated (Table I) of three distinct groups of aircraft, helicopter, fixed wing, and jet. The peak decibel level is reached

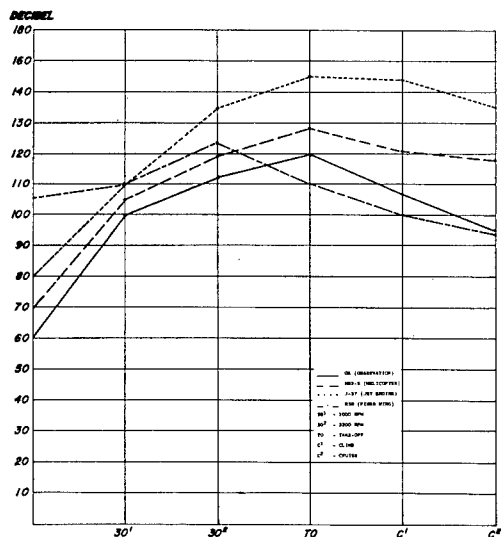


Fig. 3. Noise levels encountered within a 30-foot working area, 1000 and 2000 rpm, take-off, climb and cruise. Solid line represents OE (Observation); dotted line, J-57 (Jet Engine); broken line with even spacing, HR2-S (Helicopter); broken line with uneven spacing, R5D (Fixed Wing). Other symbols: 30¹—1000 RPM; 30²—2200 RPM; TO—Take-Off; C¹—Climb and C²—Cruise.

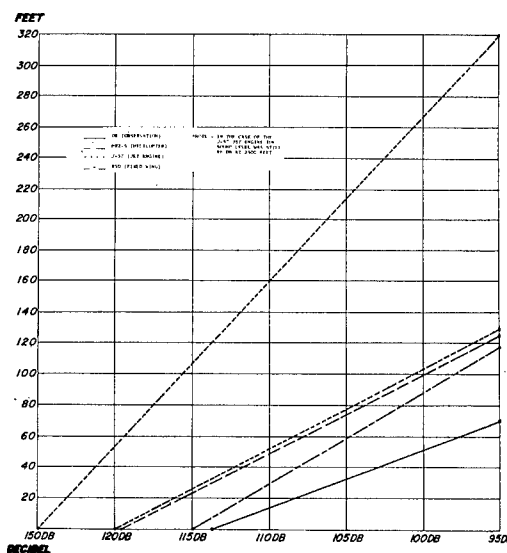


Fig. 4. Actual distances from aircraft required to reach the recommended 95 db limit for mandatory use of sound-attenuating devices. Solid line represents OE (Observation); dotted line, J-57 (Jet Engine); broken line with even spacing, HR2-S (Helicopter); broken line with uneven spacing, R5D (Fixed Wing). In the case of the J-57 jet engine, the sound level was still 96 db at 2500 feet.

in the octave spread of the internal combustion engines in the 600-1200 cps range, following which the level begins to decline. With jet engines the peaks are reached at about 1200-2400 cps and show a more gradual decline to the limits of our testing capabilities, 10 KC.

Noise level studies were then conducted within the working area of the four various aircraft types with a standard power setting of 1000 revolutions per minute, where crew members and linemen would normally be making final checks in the near vicinity of the aircraft. Recordings were also made during the normal run-

up to 2200 rpm at a distance of 30 feet. The power setting of the J-57 engine was determined in percentages of full power (Fig. 3).

Using the same type aircraft, a graph was made showing the distances which would be required from the aircraft under actual working conditions to reach the 95 db limit without hearing protection (Fig. 4). The small OE required a 70-foot leeway to reach this level, while the J-57 engine reached extraordinary proportions. During one reading, 2500 feet distant from a jet testing area, we were unable to record any findings below 96 db.

Environmental background noise testing was performed at this station, MCAS, Beaufort, South Carolina (F8U) and MCAF, New River, North Carolina (helicopters). The sustained noise level in and around hangars during normal working hours varied from 90 to 110 db. This would include the majority of the office spaces within the hangars. Immediately outside one hangar during testing of the J-57-8B engine found in F8U and F4D type aircraft the noise varied from 110 to 120 db at a distance of 450 feet from the generating source.

Readings were made in the area of a base operations building of single and formation take-offs involving F4D and A4D jet aircraft. During the initial run-up periods, just prior to brake release, noise levels reached 114-116 db. When afterburner was applied by F4D aircraft 116-124 db were recorded at approximately 750 feet. These levels were of very short duration (1 to 2 seconds) and dropped to 108 downward in the doppler effect to 94-96 db. This level dropped to 92-94 db within hangars but was evenly distributed throughout.

One of the air stations was so designed as to place the aircraft parking ramp, a hangar, operations building and temporary office spaces in tents adjacent to runways; in addition, a jet engine test area was located approximately 2500 feet away. During run-up of a J-57 engine at this test stand, the noise level reached and remained at 96 db in and around the vicinity of the tents. In another area, a temporary jet run-up test stand was located approximately 400

feet away from a group of tents provided for housing and office spaces for ordnance and electronic technicians. Frequent tests were performed during the day in this area. Recordings were made during testing with a noise suppressor and a wind of 20-25 knots blowing from the meter to jet stand. Sound level in front of these tents varied from 105 to 110 db, and at 650 feet in front of the hangar, 98 to 100 db. Many personnel in these areas complained that the noise levels reached almost intolerable proportions during this period. An unexpected noise source was encountered during the check of an electrical system of an F8U when the avionics technician started an NC-5 generator. Sound level readings indicated 100 to 102 db at the rear and 98 db at the front of this portable generator.

DISCUSSION

A decibel in ordinary usage is the ratio of any sound to the lowest sound pressure level the average person can hear—0.0002 dynes per square centimeter. It is in these values that readings are taken from a sound level meter.

In assessing noise nuisance levels,⁶ it must be remembered that a difference of a few decibels in sound intensity can make a tremendous difference in the noise reaching the ear in the form of vibrational energy. In fact, increasing the intensity of sound by three decibels approximately doubles the sound energy. The frequency or frequencies of the offending sounds must be considered. All noises send out sound waves which vibrate at various rates. The number of times the sound waves emitted exert a pulsating pressure on the ear per second is the frequency of sound. Average hearing responds from about 15 cycles per second to 15,000 cps.

The human ear responds to different frequencies, so that a sound of low frequency must be louder in intensity to hear than a sound of higher frequency. The ear is most susceptible to damage from loud noises for the frequencies around 4000 cps, possibly due to the outer and middle ear mechanisms having a higher transmission efficiency in this region than they have

HEARING CONSERVATION PROGRAM—WITWER AND COLE

at higher or lower frequencies. Those in whom the loss is centered in this high range suffer quite extensive damage before the speech range fatigue, irritability, loss of alertness, and carelessness.³ The noises of reciprocating engines and of jet

TABLE II. AVERAGE OCTAVE BAND NOISE LEVEL REDUCTION IN EAR CANAL ACHIEVED BY USE OF PERSONAL PROTECTIVE EQUIPMENT¹

| Types of Equipment Used | 300-600 cps. | 600-1200 cps. | 1200-2400 cps. | 2400-2800 cps. |
|--|--------------|---------------|----------------|----------------|
| Headset earphone covers | -7 db | -13 db | -20 db | -30 db |
| Standard ear plugs (V-51R) | -18 db | -18 db | -25 db | -29 db |
| Navy ear muff straightaway 400-9 | -25 db | -26 db | -30 db | -38 db |
| Standard ear plug and ear muff used together | -27 db | -28 db | -30 db | -40 db |

(300 to 3000 cps) is appreciably affected, and long before they become aware of a change in auditory acuity.⁴ Low frequency (from 37.5 to 200 cps) normally assails the ear as thud, or rumble. Middle frequency (300 to 2400 cps) usually roar or clang. High frequency noise, the most irritating of all, hisses or clicks.⁷

If the human ear is exposed to a loud enough noise for a long enough period, or for sufficiently repeated periods, a loss of hearing will result which will be either temporary or permanent in nature. In different individuals there is a wide range of tolerance and where one person seems to be very resistant, another, for no known reason, is susceptible.²

The average person exposed to 90 db for six to eight hours will generally show a slight loss of hearing which will return to normal in an hour or so following exposure. (The authors found the recovery time to normal hearing, using audiometric testing, to be closer to eight hours). Following a few hours' exposure to 115 db, the average pilot will show a moderate temporary loss of hearing for the middle and high frequency range for several minutes to several hours afterward. Noises of 120 db and above cause very rapid fatigue and the effects become apparent in a few minutes and may cause marked losses. In any given individual the amount of loss and the period required for recovery are proportional to both the intensity of sound and its duration.

Noise undoubtedly has an effect on the nervous system, creates an increase in blood pressure and muscular contractions with resulting

engines differ greatly during ground operations. The first type noise is discontinuous having a low fundamental and rapidly falling-off in intensity as frequency is higher. It differs from noise in flight in that there is no continuous component of aerodynamic origin. There is less sound in the higher range than there is during flight because the contribution of the slipstream is missing.

The noise of jet aircraft operating on the ground is continuous and is not only higher throughout the audible frequency range but has usually one or more intense peaks superimposed. These reflect the siren-like effect of the turbine wheel and increase in frequency with rise in revolutions per minute. With increases in power, the mass of the noise is shifted to the lower frequency range. The addition of after-burners adds greatly to the noise in the low to middle frequency and increases the overall intensity, but the higher frequencies are still very intense, and the effect is that of a tremendous and smooth roar.

In piston engine type aircraft of the conventional type, all but two frequency bands are within 10 db levels of each other so that most of the spectrum contributes to the noise level and no peak frequency stands out. It should also be noted that the highest portion of jet noise is the same range as that for speech. Cycles per second extend above and below range of jet engines as compared to reciprocating aircraft. Sound pressure levels in all frequencies of jet engines tend to mask auditory abilities but damage may still occur. It is for this reason that

HEARING CONSERVATION PROGRAM—WITWER AND COLE

the jet masks the unprotected ear so much more thoroughly and makes the hearing of speech impossible in the jet as compared to other type aircraft.^{2,3}

Our measurements of the noise levels in which men must work showed that all USMC type aircraft tested generated from a minimum of 88 db (OE-2) to a maximum of over 150 db.

Corrective Action.—With the foregoing information and the improbability of an effective noise abatement program, it becomes obvious that personal protective measures must be utilized. Present ear protectors, when properly fitted, are successful in attenuating noise in the high frequency range as shown in Table II.

Furthermore, ear protectors change the dynamic character of the listener's ear. When a masking high level noise is present a man's ability to hear and understand the spoken word is usually improved if he wears ear protection.

A five-stage hearing conservation program is now nearing completion at this Air Station accomplished by (a) detection and correction of those problems already materialized by prolonged exposure to hazardous areas, (b) education of all exposed personnel as to sources and effects of sound, (c) provision of adequate testing facilities and protective devices. All male marine personnel are given a base-line audiogram upon first reporting for duty. Follow-up examinations are then conducted annually upon all aviators, crew, and aviation ground personnel. During the past eighteen months approximately 9,000 personnel have been evaluated, problem cases treated, and 11,500 protective devices issued. Individuals who accumulated a loss from day to day were removed from the job, or provided adequate protection before impairment had reached excessive levels. If their hearing did not recover appreciably with long time allowances, permanent removal from the area was recommended. (d) The noise hazardous areas were physically delineated by posting signs which gave the normal decibel level in that vicinity. (e) Ear protection was made available to all passengers and crew mem-

bers flying in helicopters and R4Q transport aircraft.

Close cooperation between commanding officers and the Medical Department was necessary and obtained. Results to date have been most satisfactory as evidenced by a marked reduction in our "hearing" problems and improvement in repeat audiograms. We are also convinced that aviation safety among the ground personnel will be advanced to a greater degree of effectiveness through this program.

SUMMARY

Perhaps the greatest value of this study to us was the reversal of our previously complacent attitude. It is unlikely that engineering controls in noise abatement will ever keep pace with technological advances which have and will continue to increase noise output. Nor can we assume that the human ear will eventually build up a tolerance to noise pressures.

For the present time we must protect our technicians from physical damage and from the loss of their highly skilled services. It cannot be assumed that these men are to be a calculated risk when working on an engine that may exceed a level of 180 db.

ACKNOWLEDGMENTS

The authors are indebted to Staff Sergeant Ronald G. Schroeder, Sergeant W. W. Herron, and Corporal J. Bator, Jr., of the Art Department and Photographic Laboratory, U. S. Marine Corps Air Station, Cherry Point, North Carolina, for their valuable assistance in the collection of these data.

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Clinical Problems in Aviation Medicine

EDITOR'S NOTE: AEROSPACE MEDICINE is establishing a new section to present, on a scheduled monthly basis, *Clinical Problems in Aviation Medicine* encountered in pilots and other members of the aircrew. Dr. Jan H. Tillisch and Dr. Earl T. Carter of the Mayo Clinic will present these problems in the form of *Case Reports*. It is hoped that the presentation and solution of clinical problems will be of practical value to the readers of the *Journal* and will serve to supplement the increasing number of excellent case studies appearing with greater frequency in the *Journal*. If you approve (or disapprove) of this section, I shall be pleased to receive your comments.

JOHN P. MARBARGER, *Editor*

Case Report Number 1

JAN H. TILLISCH, M.D. and EARL T. CARTER, M.D.

THE DIFFERENTIAL DIAGNOSIS between an organic and a functional disease is a constant challenge to the practicing physician. The importance of a correct conclusion is even more pressing when the patient is a pilot and when one of the organic diseases considered can lead to sudden and unexpected disability of the victim, thus endangering not only the patient's life but the lives of others. The following report of a case illustrates such a problem and the specific solution.

REPORT OF CASE

A white man, twenty-nine years old, was referred to the Mayo Clinic for examination and a decision as to the advisability of continuing his duties as a pilot. The patient was employed by a commercial firm as a pilot, and was actively engaged in flying both single and twin-engine aircraft, both with and without another pilot. A year previously, the patient had first noticed increased fatigue, loss of motivation, lack of interest in social activities and a feeling of anxiety. At the onset these symptoms occurred intermittently, but gradually they became more severe and constant.

Six months before his examination, the patient had undertaken a normal flight. Because the flight was to start early in the morning, the patient had missed breakfast. During the flight, he made several routine

landings and take-offs without incident. After several hours' flying, he became fatigued, and while flying at an altitude of 6,000 feet in an unpressurized cabin without supplemental oxygen he suffered the first of the episodes of which he complained. He described the condition as being "a feeling of something wrong without being able to tell what." He then noticed a tingling sensation and tightness of the scrotal muscles, "like when you are scared." This tingling sensation extended up the back, over the top of his head "like a curtain," and down the forehead to the eyes. He felt lightheaded and thought he might lose consciousness. This episode lasted several minutes, but he did not actually lose consciousness and since the aircraft was being controlled by the automatic pilot, no alteration in flight attitude occurred. Similar episodes were repeated with increasing frequency, and occurred at any time of the day or night. In almost every instance the incident was preceded by a sensation of anxiety but no specific aura. At no time did the patient actually experience convulsions or nausea or emesis, or become incontinent or lose consciousness.

A most interesting feature was the remarkable sensation of "feeling apart from his body" which this patient experienced during the attacks. He reported that it was as if he were an observer not actually involved. Environmental sounds commonly assumed an "echo-chamber" quality. Invariably, the attacks were followed by a marked feeling of fatigue. Although most episodes occurred while he was on the ground, several occurred while he was in flight, but he was always able to "just hang on" and to maintain proper cruise attitude. Fortunately, no attacks occurred during landing or take-off procedures.

From the Section of Medicine, Mayo Clinic and Mayo Foundation, Rochester, Minnesota.

CLINICAL PROBLEMS IN AVIATION MEDICINE

A month or two after the onset of these attacks, the patient experienced frequent sensations of respiratory difficulty in flight which he described as a substernal pressure and a sense of inability to inspire sufficient air in the thorax. These episodes usually occurred while he was flying the plane at an altitude of 4,000 to 5,000 feet. They were not associated with the psychosensory phenomena described above and did not occur while he was on the ground.

The patient reported to his company physician because of these complaints. Results of a complete examination done at this time were within normal limits, and although the value for fasting blood sugar was normal, a provisional diagnosis of spontaneous hypoglycemia was considered. A high-carbohydrate, high-protein diet was prescribed as a therapeutic trial. The pilot was returned to regular flying duties.

Despite these measures, the psychosensory attacks became more pronounced and the patient again returned for counsel from his company physician. Neurologic consultation was obtained. Examination of the central nervous system gave objectively negative results. An electroencephalogram made at this time showed paroxysmal slow activity in both frontoparietal areas as well as small, sharp spikes. The possibility of psychomotor epilepsy was considered, and pending further studies the patient was not allowed to fly aircraft. One hundred milligrams of diphenylhydantoin sodium (dilantin sodium) and 15 mg. of phenobarbital, to be taken three times daily, were prescribed.

The patient was referred to the Mayo Clinic at this time, which was a year after the onset of the original symptoms. His family history, including convulsive or emotional disorders, was not significant. It was found that during childhood the patient had experienced two convulsions coincident with a high fever. The patient described his symptoms as previously noted, with the additional information that the attacks were occurring with increasing frequency and that "déjà-vu" phenomena were more pronounced.

Results of physical examination were essentially negative. Weight was 171 pounds and blood pressure 140 systolic and 80 diastolic, in millimeters of mercury. Results of urinalysis, roentgenograms of the thorax and skull, erythrocyte and leukocyte counts, differential leukocyte count and electrocardiograms all were normal. The value for protein-bound iodine was 4.8 micrograms per 100 milliliters of serum; the basal metabolic rate was -8 per cent and the value for true blood sugar was 73 mg. per 100 cc. of blood (normal, 60 to 90 mg). Serologic tests gave negative results. The initial electroencephalogram obtained was reported as follows: "There is alpha activity of 8-9 cps which is rather poorly organized but approximately symmetrical on the two sides. There are some diffusely intermingled low amplitude waves

in the 5-7 cps range which appear when the eyes are closed during the resting record. These are increased in prominence during hyperventilation and photic stimulation elicits a moderate symmetric driving response."

The interpretation was thus, "The electroencephalogram shows minimal irregularities but the pattern can be considered as being within normal limits."

The patient was then referred to the Section of Neurology, but results of a detailed neurologic examination were essentially negative. However, in spite of the lack of objective evidence and the bizarre aspects of the history, it was decided that a sleep electroencephalogram should be made. The patient's symptoms of "feeling apart from himself" and "hearing things from afar," plus the recent accretion of "déjà-vu" phenomena were suggestive of temporal-lobe seizures. A sleep electroencephalogram was obtained and was described as follows: "A sleep recording was accomplished after premedication with a total of three grains of seconal and utilizing added anterior and posterior temporal electrodes bilaterally. Adequate stages of sleep were attained and during light and moderate sleep there are frequent medium amplitude sharp discharges emanating maximally from the right anterior and mid-temporal regions, these at times apparently occur bi-synchronously in homologous areas on the two sides and occasionally there are independent less frequent sharp discharges from the temporal region. There was no further abnormality on arousal."

The clinical interpretation of this report was: "The electroencephalogram during sleep shows a marked activation of a definite spike discharge maximal in the right temporal region but with occasional independent firing from the left. The character of this discharge would be compatible with the presence of a seizure disorder."

On the same day, recordings were obtained from nasopharyngeal leads, but they showed no definite abnormality. The figure illustrates the characteristic temporal spikes encountered in electroencephalograms in this case.

Thus, the diagnosis of psychomotor or temporal-lobe epilepsy was made. Permanent grounding of the pilot was recommended, and it was also urged that he not drive an automobile. A combination of dilantin, phenobarbital and desoxyephedrine hydrochloride (phelan-tin), one capsule to be taken three times daily, was prescribed in place of the dilantin sodium.

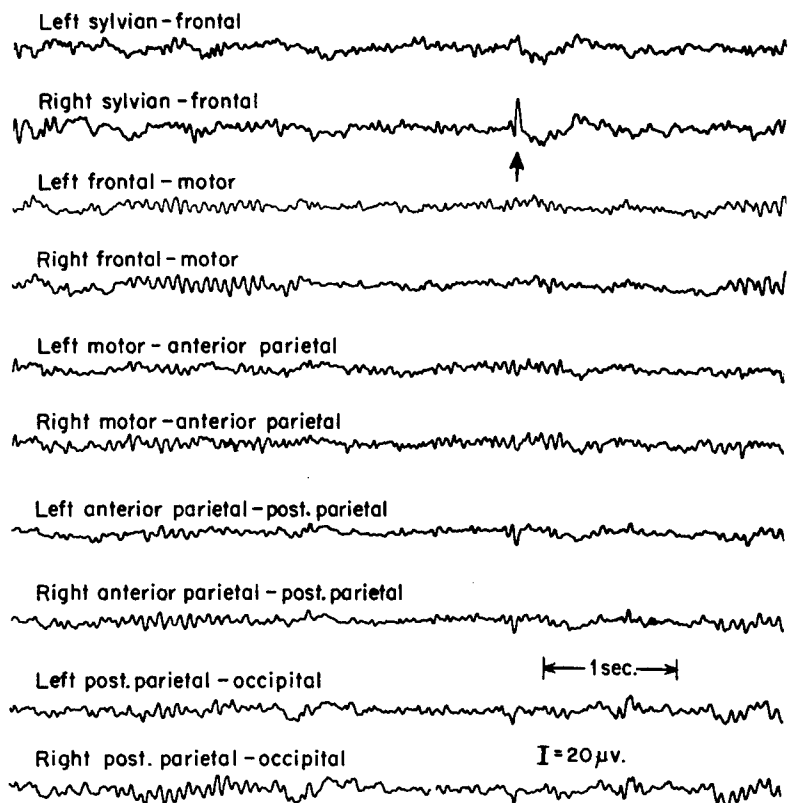
COMMENT

Several points in this case require special emphasis. When the patient was first seen, he described a bizarre episode which was not accompanied by convulsions. There is always a strong

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tendency for the physician to consider such a condition as an emotional problem, although in this instance the patient was given the benefit of the doubt. The presence of hypoglycemia was

pattern of such a sensitive person cannot be distinguished from that of an epileptic person in the absence of a disorder in glucose metabolism. When a diet is prescribed for hypoglycemia, es-



Characteristic temporal spikes in the electroencephalogram of the patient in the case reported. The tracing was made while the patient was asleep.

postulated, and a therapeutic diet was tried. However, the episodes were not confined to relative fasting periods and also were not preceded by the sensations of lassitude and hunger typical of attacks of hypoglycemia. True "spontaneous hypoglycemia" is indeed rare, and in fact cannot be substantiated without observance of a marked decrease in the content of blood glucose immediately prior to or during a seizure, preferably to a value of less than 50 mg. per 100 cc. of blood.

Of particular significance is the fact that true epileptic seizures may be precipitated by relative hypoglycemia, and the electroencephalographic

pecially as a diagnostic test, it is important not only to instruct the patient as to the types of food consumed but also in the timing of ingestion. The avoidance of prolonged fasting periods and the use of between-meal snacks should be a part of the diet program.

The significance of the episodes of subjective dyspnea during flight is unclear. In view of the absence of evidence of cardiopulmonary disease, we believed that these complaints were functional and associated with the patient's concern about the seizures.

Detection of psychomotor epilepsy (sometimes referred to as "temporal-lobe seizures" or

"epileptic equivalents") is not always simple on the basis of ordinary clinical procedures alone. There is no end to the varieties of episodes which a patient who has this disorder may experience. Seizures may vary from a transient lapse in awareness to a complex fugue or psychosis. Fits of dancing, jumping, running, laughing and crying may break out. Extremely bizarre behavior may be associated with equally bizarre subjective complaints, and it is very common to find that a patient who has psychomotor epilepsy is somewhat "odd." (This was not so in the case described herein.) The implication is obvious: in many cases, psychomotor epilepsy is at hand but is unrecognized in persons going freely about who are characterized as "eccentrics" or "psychoneurotics." Many patients are reluctant to describe their attacks simply because the episodes are so bizarre and unbelievable.

It is important to make the correct diagnosis because temporal-lobe seizures often are ultimately associated with seizures of grand mal. Moreover, there is always the possibility that a neoplasm is the underlying cause. Careful examination for a tumor of the temporal lobe is indicated in every case. In the case we have presented there appeared a characteristic of temporal-lobe seizures which must always be considered, meaning that the electroencephalogram made while the patient was awake was not diagnostic or was equivocal. Hence, in such a circumstance a sleep electroencephalogram should be made. Occasionally, nasopharyngeal leads will yield records with abnormalities which are not forthcoming when the leads are used in the usual positions.

A detailed differential diagnosis of psychomotor epilepsy is beyond the scope of this report, but several conditions which might mimic this disorder can be mentioned. Narcolepsy,

psychiatric disorders, the hyperventilation syndrome and pheochromocytoma usually do not represent a diagnostic problem. Vasodepressor syncope, however, can be difficult from the standpoint of differential diagnosis. Temporary embarrassment of the cerebral circulation leading to syncope or "seizures" occurs in the presence of the Stokes-Adams syndrome, hypersensitivity of the carotid sinus, transient cardiac arrhythmias and certain forms of "vasovagal syncope" associated with breath-holding, pressure breathing or positional changes. Typically, the vasodepressor type of seizure is not associated with abnormal electroencephalographic patterns and, if loss of consciousness ensues, there is a "limp fall" instead of the myotonic or myoclonic phenomena seen in epileptic-like seizures. However, exceptions do occur.

It seems unlikely that anyone would disagree with the disposition of the patient in the case just described. The incompatibility of such a syndrome with flying is obvious. The patient inquired as to whether or not he would be able to resume his work as a pilot if it should happen that he would be free from attacks for a year or two while he was taking medication. It was our opinion that prolonged freedom from seizures while the patient was taking medication should in no way alter the initial disposition of the case. Guarantee of continued effectiveness of a given drug is not possible, even if it could be certain that there would be no lapse in therapy or no untoward side effects.

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President's Page

Aerospace Medical Association



ADMIRAL J. L. HOLLAND

Invitations have been received inviting any of our interested members to attend two very interesting and important meetings this fall. One will be held in Paris, France, and the other in Washington, D. C. Announcements of these have been carried in the journal for several months.

The International Congress of Aviation and Cosmonautical Medicine convenes in Paris, France, September 26, and is in session through September 30. This Congress is sponsored by the Ministers of the Departments concerned, with the support of the French Aviation and Cosmonautical Society and the French Astronautical Society. An interesting array of papers has been selected for this meeting. The presiding officer of the Congress will be Professor Robert Grandpierre, General Medical Officer of the Air Health Department of France, and one of the Vice Presidents of our Aerospace Medical Association.

The second meeting of interest to some of our membership is the 12th International Astronautical Congress to be held in Washington, D. C., October 2-7. The Aerospace Medical Association is a member of the International Astronautical Federation, the sponsor of the Congress. The American Rocket Society is the host for this meeting in the United States. ARS's Samuel Herrick, Chairman of the Congress Committee, has invited attendance from all IAF Member Societies and their members.

The Bioastronautics Program at the Congress will be divided into technical sessions with formal paper presentations and round-table discussions covering specific topics. On October 2, there is the Life Sciences Committee Meeting with Panel Reports on the Topics "Bioastronautics Information Exchange" and "Tolerance Criteria for Radiation Exposure During Space Flights." At the First Bioastronautics Session on October 4, these papers will be presented: "Regeneration: Chemical or Biological"; "Bio-Engineering Investigation of Integrated Physico-Chemical Life Support System Concepts"; "Life Support System—Slave or Master?"; "Influence of Lunar and Zero Gravity Upon Germination and Growth of Plants" and "Mars as an Object of Exploration and Settlement."

The Second Bioastronautics Session, also on October 4, will cover subjects of "Psychophysiology"; "Psycho-Physiological Reactions to Weightlessness as Observed on Subjects During Recent Bioballistic and Biosatellite Experiments"; "Information Filtering in Quick-Reaction Human Monitored Systems"; "Analysis of Missions of Multi-Man Space Crews in Relation to Time in Space and Space Task Performance" and "Flight Safety Systems for Advanced Manned Space Missions."

The Bioastronautics Round Table on October 6, will be on "Men under Space Flight Stresses" and encompass a discussion on the basis of man's responses to situational-environmental stresses. Many members of the Aerospace Medical Association from the United States and abroad will present papers and participate in all of these sessions.

Aerospace Medical News

FAA Reorganization Provides for "Aviation Medical Service"

Little change in the functions or relationships of the Civil Air Surgeon and the Aviation Medical Service, formerly Bureau of Aviation Medicine, is anticipated under the new organization status within the Federal Aviation Agency. The evolutionary modernization program for the Federal Aviation Agency, developed by N. E. Halaby, Administrator, got under way July 1, 1961. Basic to the Agency's streamlining actions to provide better and more efficient management of its resources is the broadened authority of the Agency's Regional Offices. The Regional Offices to be headed by Assistant Administrators will now be responsible for direction and execution of all FAA programs in the field, subject to direction and guidance from Washington Headquarters, which retains responsibility for developing national programs and policies. Geographical names for the Regional Offices replace the previously used number system. A new Southern Region, with headquarters in Atlanta, Georgia, brings the number of regions to seven.

Reorganization of the Washington headquarters provides for three deputy administrators to be responsible to Mr. Halaby for the planning and directing of the operations of the Agency. The statutory Deputy Administrator will serve as general manager for Agency Operations and will be responsible for coordinating activities of the regional offices and the following Services: the Air Traffic Service, Aviation Facilities Service, Flight Standards Service, Aviation Medical Service, International Aviation Service. The other two are the Deputy Administrator for Plans and Development who will coordinate long-range planning, and research and development programs and will supervise the Office of Plans and the Aviation Research and Development Service, formerly the Bureau of Research and Development, and the Deputy Administrator for Administration, who will be responsible for administrative management programs of the Agency.

The Aviation Medical Service (formerly Bureau of Aviation Medicine) was created to advise the Administrator of the Federal Aviation Agency directly on matters of aeromedical policy and practice. The medical responsibilities and mission of the FAA are implicit as defined by the Federal Aviation Act of 1958. They primarily concern the fact that the airman must be physically able to perform his duties, and that the Administrator must determine that the applicant is so qualified.

To support the medical certification function, four divisions have been established in AMS in the Washington Office: Research Requirements, Medical Standards, Medical Certification, and Environmental Health; also the establishments at Georgetown University and

the Civil Aeromedical Research Institute at Oklahoma City, Oklahoma, fulfill the needs for research in a large number of medical areas.

To efficiently accomplish the large medical examination load 4,983 examiners have been appointed as of July 1, 1961. As an aid to the Aviation Medical Examiner, the Seminar Training program affords the examiner information in evaluating the physical fitness required of civilian airmen under currently effective standards and discusses findings produced through the medium of scientific research in the field of aviation medicine. The three-day seminars at medical schools around the nation provide a means of keeping Aviation Medical Examiners in this specialized field fully informed and of creating uniformity in the physical examination of airmen. Most of the FAA medical examiners are general practitioners while others are specialists and would thus approach a medical examination from diverse viewpoints. Emphasis in the seminars is given to those physical factors important to safe flying such as the heart, eyes, lungs, ears, nose and throat. These programs average two a month. To date, 601 Aviation Medical Examiners have attended.

Positions are now available in the Aviation Medical Service to physicians with an interest and background in aviation medicine in Washington, D. C., New York City, and Los Angeles, California. Research scientists are needed at Oklahoma City, Oklahoma. The Research Requirements Division, Aviation Medical Service, has an immediate position available for a physician qualified in the field of aviation medicine who has had four years of progressively responsible experience in the practice of medicine.

Dr. Goddard Reappointed

Dr. James L. Goddard will continue to serve as the Federal Aviation Agency's Civil Air Surgeon for an additional two years under an agreement made with the U. S. Public Health Service at the request of FAA Administrator, N. E. Halaby. As Civil Air Surgeon and head of the Aviation Medicine Service, Dr. Goddard is concerned with the mental and physical fitness of airmen and air traffic controllers. He develops and recommends FAA's medical standards for airmen, controllers and others concerned with aviation safety; and conducts aviation medical research into the physiological and psychological limitations of the human body that may affect man in flight.

Dr. Goddard has been a career public health officer since 1951, when he gave up his private medical practice in Kalida, Ohio, to accept an appointment with the U. S. Public Health Service in Denver, Colorado. He held assignments of increasing responsibility in the Public Health Service, and prior to his FAA appointment in 1959, had been serving as Chief of the Accident Prevention Program, Bureau of State Services. While there, he was responsible for developing and administering a nationwide program to cut down deaths, disabilities, and injuries from accidents of all types. Dr. Goddard holds a commissioned rank of medical director in the U. S. Public Health Service.

He is a member of the Executive Council of the Aerospace Medical Association, the National Advisory Council Law-Medicine Research Institute, Boston University, and the Scientific Advisory Committee of Consumers Union; as well as advisor to the Human Factors & Bioastronautics Committee of the American Rocket Society and the American Board of Preventive Medicine.

Dr. Mohler to Head FAA's Civil Aeromedical Research Institute

Dr. Stanley R. Mohler has been named Director of the Federal Aviation Agency's Civil Aeromedical Research Institute in Norman, Oklahoma. He succeeds



DR. MOHLER

Dr. Hilliard D. Estes who has been appointed Chief of the Bureau of Aviation Medicine's Environmental Health Division at FAA Headquarters, Washington, D. C. The Institute, which is under the direction of the FAA's Bureau of Aviation Medicine, has been established to carry out

research to meet both existing and anticipated aeromedical problems to pro-

mote air safety. Dr. Mohler will have the overall responsibility for the human factors research conducted there.

Doctor Mohler transfers to the FAA from the National Institutes of Health, where he has been a Commissioned Officer in the U. S. Public Health Service for the past four years. While there, he served as Medical Officer of the Center for Aging Research, and Technical Director for Research in Gerontology. He was designated a member of the Medical Committee of the January 1961, White House Conference on Aging.

Doctor Mohler is familiar with the research activities of the Federal Aviation Agency, both as a member of the Civil Air Surgeon's Research Advisory Group and the FAA's Advisory Board for Research in Aging. In 1956, he was on duty at the U. S. Public Health Service Hospital in San Francisco. Prior to that time he held several positions in private industry.

A native of Amarillo, Texas, Doctor Mohler received his B.A., M.A. degrees and in 1956 his Doctor of Medicine degree from the University of Texas. He is a licensed private pilot and a member of a number of professional and scientific societies including the Aerospace Medical Association, the American Medical Association, and the American Geriatrics Society.

Dr. Estes, Chief, Environmental Health Division

Dr. Hilliard Estes, a native of St. Joseph, Missouri, received his Doctor of Medicine degree from the Harvard Medical School in Boston, Massachusetts,



DR. ESTES

and a Master of Public Health from the Harvard School of Public Health. He also took several advanced courses in the United States Air Force School of Aviation Medicine.

As Chief of the Environmental Health Division, Doctor Estes will be responsible for the research on the physical environment re-

quired to maintain safe, healthful and comfortable conditions in air transportation and ground facilities. This includes study of oxygen conditions, radiation, environmental temperatures and noise levels. He also has responsibility for the overall employee health program in FAA.

Prior to being designated Director of the FAA's Civil Aeromedical Research Institute in July, 1960, he was with the Lovelace Foundation in Albuquerque, New Mexico, working in the area of Aerospace Medi-

AEROSPACE MEDICAL NEWS

cine. From 1955 to 1959, he was with the USAF as Flight Surgeon and Command Pilot and as Chief of Aviation Medicine with HQ Air Defense Command, Colorado Springs, Colorado. From 1952 to 1954 he was Medical Director of Abqaiq District for the Arabian American Oil Company in Saudi Arabia and from 1951 to 1952 he served with the Atomic Energy Commission as a Fellow in Industrial Medicine.

He is a member of the American Medical Association, Aerospace Medical Association and a number of other professional organizations, and has been certified by the American Board of Preventive Medicine in Occupational Medicine. He holds a pilot license.

* * *



DOCTOR ROADMAN SEES STARS. On August first, Mr. James E. Webb, Administrator, National Aeronautics and Space Administration, and Maj. Gen. O. K. Niess, the USAF Surgeon General, pinned stars on Brig. Gen. Charles H. Roadman, USAF, MC (center). General Roadman is Acting Director, Office of Life Science Programs, NASA.

2000-MPH Civil Transports

Three Agencies report feasibility of 2000-MPH Civil Transports. Development of a commercial transport plane to fly three times the speed of sound (Mach 3) is feasible, and could be done by 1970-71. The industry estimates there is a world market for upwards of 200 such planes.

This is the major conclusion of a booklet, "Commercial Supersonic Transport Aircraft Report" issued by the Federal Aviation Agency, the Department of Defense and the National Aeronautics and Space Administration. The 50-page report was signed by N. E. Halaby, Administrator of the FAA, James E. Webb, Administrator of the NASA and Robert S. McNamara, Secretary of Defense. A Task Group of the three agencies prepared the report as a review of information gathered from industry and government sources. It is available, in limited quantity, from the FAA.

In discussing the tri-agency cooperative effort, Administrator Halaby said: "Progress with safety in aviation is our business."

Letter to the Association

FEDERAL AVIATION AGENCY

Washington 25, D. C.

Dear Doctor Kennard:

We are deeply appreciative for your letters of May 29 and June 1, 1961, and the transmittal of the five resolutions adopted at the 32nd Annual Meeting of the Aerospace Medical Association on April 25, 1961. It is gratifying to me to note that your group maintains an active interest in the Agency.

I have referred the resolutions to the several bureaus involved and asked that they take whatever action is appropriate. Your offer of assistance is indeed generous and, in turn, we offer to your group any assistance that the Federal Aviation Agency may give. We also wish them continuing success in their endeavors in aviation medicine.

Sincerely yours,

N. E. HALABY

Administrator

Command Changes at RCAF Institute of Aviation Medicine

Hugh B. Hay, RCAF, has been promoted from W/C to G/Capt. and has been assigned to command the Institute of Aviation Medicine in Toronto. The former Commanding Officer, G/Capt. Donald G. M. Nelson, has been transferred to the Canadian Joint Staff in London, England. G/Capt. Hay comes from Air Transport Command Headquarters at Trenton, Ontario, and brings with him considerable air crew experience which he gained flying regularly with the air crews of his Command. His recent flying experience is in addition to a distinguished wartime career as a pathfinder navigator, in which capacity he completed three operational tours and subsequently took his pilot training. He was decorated with the Distinguished Service Order and the Distinguished Flying Cross.

RCAF Institute Hosts Joint Committee on Aviation Pathology

The JCAP will hold a Scientific Meeting in Toronto from the 17th to the 19th of October, 1961. G/Capt. H. B. Hay, Commanding Officer, RCAF, IAM, will be host to the Committee on behalf of the Surgeon General, Canadian Forces Medical Service. Papers on Aviation Pathology and Toxicology, Flight Safety and Accident Investigation will be presented. The Committee intends to publish the papers as JCAP Memoranda.

American Board of Preventive Medicine Meets

Admiral Holland, in his President's Page last month, reported to you on the significant actions taken by the American Board of Preventive Medicine. Since a large number of people will be interested in the recent Board actions, it is appropriate to repeat and amplify Admiral Holland's report of the meetings of the Board on 6-7 June, 1961.

Changes in Requirements for Certification in Aviation Medicine

The most important action was the reduction from four to three years in formal training required. The new program consists of one academic year of graduate study at an accredited School of Public Health (or its equivalent), and a two-year residency in aviation medicine. The residency must include an academic component during which the special subjects essential to a knowledge of aviation medicine are presented, and an applicatory component during which the trainee progresses, under supervision, through a planned program involving experience in both clinical and administrative aviation medicine. It is expected that the applicatory phase of the residency will normally be arranged at various training sites affiliated with schools offering the academic portion of the program. It is believed this change will place training programs within the capabilities of additional civilian agencies.

Besides the formal training program of three years' duration, the Board requires three full years of practice, teaching, or research in aviation medicine. A total of six years in training and practice in the specialty is thus required. Questions have often been raised as to whether or not practice of aviation medicine performed prior to entry into the full residency program may be counted toward the requirement for three years of practice. Applicants may be assured that such time may indeed be counted, if it is begun with an actual formal course in aviation medicine. Applicants who have been in continuous training or full-time practice of aviation medicine may start counting their six years with the date of entry into the first formal course in the specialty.

Examinations—Parts I and II

A second action of the Board was to authorize the taking of the examinations in two parts. Part I will be the "core," consisting of questions on preventive medicine in general, common to all the sub-specialties under the Board. Part II will consist of questions on the specialty of aviation medicine. Although Parts I and II may still be taken at the same session, the applicant now has the option of taking Part I after

completion of the formal training, and Part II after sufficient practice to bring his time in the specialty up to six years. Applicants will be required to submit \$25.00 with their initial application, \$50.00 on acceptance for one of the Parts, or \$100.00 on acceptance for both Parts.

Applications

A third action of the Board was to establish a firm cut-off date for acceptance of applications for examination. Examinations will normally be given in connection with meetings of the Aerospace Medical Association, in April of each year. Applications for examination in any April will not be acted upon unless received by the preceding November 30th. Application forms, as well as bulletins and other documents of the Board, are being revised.

Annual Elections

The annual election of officers and members to the Board of Trustees to fill vacancies created by normal rotation and the resignation of previous members included the following:

Officers Elected: James H. Sterner, M.D., Chairman; Richard F. Boyd, M.D., Vice Chairman for Public Health; William J. Kennard, M.D., Vice Chairman for Aviation Medicine; Lemuel C. McGee, M.D., Vice Chairman for Occupational Medicine; Tom F. Whayne, M.D., Secretary-Treasurer; Fred C. Rogers, M.D. and Frank L. Babbott, Jr., M.D., Assistant Secretaries.

Board Members Elected: Captain Merrill H. Goodwin, MC, USN, J. H. Sterner, M.D., E. L. Stebbins, M.D., Malcolm Merrill, M.D., Rodney R. Beard, M.D. and Thomas D. Dublin, M.D., the last two representing the newly authorized area for certification in general preventive medicine.

Fourteen Begin Residency in Aviation Medicine

A new group of career medical officers of the US Army and Air Force have entered on their second year of a three-year program of formal training in Aviation Medicine leading to certification by the American Board. They now begin the first year of residency training at the School of Aerospace Medicine, USAF Aerospace Medical Center, Brooks AFB, Texas. Air Force officers are Major Harvey W. Hertz and Captains Philip W. Andrews, Robert J. Brandt, Louis H. Cargill, Richard A. Davison, Clinton L. Holt, Richard L. Masters, George C. Mohn, Page Sharp, Jr., James F. Wittmer and Willis F. Wunder. Army officers are Captains Harold R. Chappell, James E. Hertzog and Roland H. Shamburek.

News of Members

Brig. Gen. Robert S. Brua, USAF, Former Command Surgeon, Hq. MATS, at Scott AFB, Ill., has been assigned as Command Surgeon, PACAF, which post was vacated by Maj. Gen. Bohannon, now Deputy Surgeon General, USAF . . .

Col. Kenneth E. Pletcher, USAF, moves to Scott as Command Surgeon for MATS, filling the vacancy left by Gen. Brua. Col. Pletcher, who was Chief, Aero Medical Division in the Directorate of Flight Safety Research, Office of the Inspector General, Norton AFB, Calif., has been relieved by . . .

Col. Emmert C. Lentz, USAF, formerly Surgeon for the 28th Air Division, SAGE, Hamilton AFB, Calif.

Capt. William S. Hark, USA, recently at Fort Belvoir, Virginia, has been reassigned to the Physical Standards Division, Office of the Surgeon General, US Army. Capt. Hark has entered a program which will include formal training leading to eligibility for examination by the American Board of Preventive Medicine.

Col. Hamilton Webb, USAF, Director of Base Medical Services, Otis AFB, advises us that . . .

Col. William Croskery, Lt. Cols. Joseph de Marco, Anthony S. Ripa and Maj. Philip B. Burke of the Massachusetts Air National Guard were on active duty with the 101st and 102nd Fighter Squadron at Otis during July and served on the hospital staff.

Dr. Med. Wilderhold Potten has completed the Advanced Course in Aerospace Medicine at Brooks AFB, Texas, and has returned to his native Germany.

Col. Allan C. Evans, USAF, formerly stationed at Barksdale AFB, La., has been recently promoted and assigned for overseas duty with the 868th Medical Group of the 4082nd Strategic Wing.

Edward L. Hays, formerly at the Naval Air Material Center, Philadelphia, Penna., is now Head, Crew Equipment Branch, Life Systems Division, NASA Space Task Group at Langley Field, Virginia, where he replaced . . .

Frank C. Robert, who has gone to the Darlington School, Rome, Georgia.

Col. Alvin F. Myer, Jr., USAF, is now attending the Industrial College of the Armed Forces at Fort Leslie J. McNair, Washington, D. C. He has previously been at Hq., SAC, Offutt AFB, Nebraska.

Lt. Cdr. Arthur J. Grote, formerly at the US Naval School of Aviation Medicine, Pensacola, Florida, is now on duty on the USS Constellation.

Herbert R. Greider, M.D., has moved from Foristell, Missouri, to Long Green, Maryland.

Capt. Edward L. de Wilton, USN, has left Wright-Patterson AFB, Ohio, and is now stationed at the US Naval Aviation Safety Center, Norfolk, Virginia.

Robert G. Busboom, M.D., who was in private practice in Greeley, Colo., is now residing in McLean, Virginia. He will join the medical staff of Group Health in Washington, D. C.

E. B. Brown, Jr., Ph.D., has transferred from the Physiology Department of the University of Minnesota to the Physiology Department of the University of Kansas.

Charlotte R. Smith is moving from Urbana, Ill., to Downer Grove, Ill.

Howard C. Seely, M.D., will be starting residency training in Portland, Oregon, this summer.

Col. Henry C. Dorris, USAF, is the new Deputy Commander of the USAF Hospital, Lackland AFB, Texas. Col. Dorris was formerly the Commander of the 2789th Hospital at Brookley AFB, Alabama.

Col. John A. Henderson, USAF, who was Chief of Professional Services of the 3970th USAF Hospital, overseas, upon his promotion assumed command of the 2845th USAF Hospital, Griffis AFB, New York.

Col. John Rizzolo, USAF, until recently the Executive Secretary of the Armed Forces Epidemiological Board, Washington, is now Command Surgeon of the 13th Air Force and Director of Base Medical Services at USAF Hospital Clark, Philippine Islands.

Col. John A. Wilkins, USAF, has been transferred from Hq. of the 3rd Air Force to Hq. of the 17th and remains overseas.

Col. S. O. Smelsey, USAF, Former Commander of the 1611 USAF Dispensary (MATS) at McGuire AFB, New Jersey, is now attending classes at the War College, Maxwell AFB, Alabama, as are . . .

Lt. Col. George E. Schafer and Maj. James H. Stuteville. Col. Schafer was last stationed at Davis-Monthan AFB, Tucson, Arizona and Maj. Stuteville on overseas assignment with the 10th TAC Hospital.

Wing Commander R. F. Jackson, RCAF, who is with the Canadian Armed Forces, Europe, has recently been promoted from Squadron Leader.

Col. Thaddeus J. Domanski, USAF, Commander of the 3790th Epidemiological Laboratory at Lackland AFB, Texas, joins the staff of the Air Force Institute of Pathology, Washington, D. C. In 1946-47 Col. Domanski was Chief, Korean Bureau of Laboratories and helped develop the Korean Na-

NEWS OF MEMBERS

tional Laboratories. Prior to duty at Lackland, Col. Domanski represented the USAF at the Army Chemical Laboratory at Fort Detrick, Md. He is an associate member of the American Society of Clinical Pathologists.

Capt. M. H. Goodwin, USN, Assistant Chief for Aviation Medicine, Bureau of Medicine and Surgery, was elected a Trustee of the American Board of Preventive Medicine during their annual meeting in June, for an additional 3-year term as a representative of Aviation Medicine.

James N. Waggoner, M.D., has been appointed Medical Director in Charge of Health, Safety and Aerospace Medicine for the Garrett Corporation. In his new position, Dr. Waggoner will coordinate the development of new Garrett products which show potential in the aerospace medical and commercial medical fields. His responsibilities extend to all eleven divisions of Garrett. Previously, Dr. Waggoner was medical director for Garrett's AiResearch Manufacturing Division of Los Angeles. He will continue to supervise AiResearch's employee medical facility. Dr. Waggoner assisted in development of the AiResearch environmental control system for NASA's Project Mercury manned satellite. Dr. Waggoner was elected a Fellow of the Aerospace Medical Association in 1960 and served as General Chairman for the Association's annual scientific meeting in 1961 at Chicago, Ill. He is a member of the faculty at UCLA and USC.

Col. John J. Kavanaugh, USAF, former chief of hospital services at the AF Academy, has arrived at James Connally AFB, Texas, to assume command of the 3556th USAF Hospital.

Lockheed Missiles and Space Company announces the installation of a 55-ton satellite "space chamber" at their Sunnyvale, Calif., plant. Principal space craft to be tested in the new "space chamber" which is designed to duplicate conditions 200 miles from the earth is Lockheed's Agena, which is used in the AF Discoverer, and Midas satellite programs.

AiResearch Manufacturing Division of the Garrett Corporation reports it has developed an automatic blood pressure measuring system which will be used to telemeter the blood pressure of an astronaut orbiting the earth. The new AiResearch system, which has commercial applications, automatically records both the systolic and diastolic blood pressure. According to James N. Waggoner, M.D., AiResearch's medical director, the blood pressure measuring system could be easily adapted for hospital use, where there is a need for the con-

tinuous blood pressure recording such as in post surgical recovery rooms and for automatic reports on patients with an illness requiring periodic blood pressure recordings. By including a warning device the new blood pressure measuring system could be an important aid to busy hospital staffs by quickly summoning necessary medical attention when the system detects blood pressure levels above or below present limits.

New Members

JAMES A. BAKER, M.D., Aberdeen, Washington
GEORGE H. BEECK, Denver, Colorado
WALTER C. BARNES, JR., Capt., USAF

RAY L. CASTERLINE, M.D., Medford, Oregon
MELVIN H. CHALFEN, M.D., Cambridge, Massachusetts
NICHOLAS C. CHUBB, M.D., Reedsville, Pennsylvania
JOHN M. CLARIDAY, M.D., Dallas, Texas
DONALD E. COOLAHAN, M.D., Scotia, California
CLAUDE ROBERT CROW, M.D., Mount Dora, Florida

A. ARMANDO DANI, M.D., Silver Spring, Maryland
RICHARD E. DANIELSON, Wichita, Kansas
WILLIAM C. DOWNING, M.D., Painesville, Ohio
BURTIS R. EVANS, M.D., Salt Lake City, Utah

VIRGIL E. FLANDERS, M.D., Kansas City, Missouri
PAUL R. FOOTE, M.D., Seneca Falls, New York
ORLEY W. FOSTER, M.D., Minneapolis, Minnesota
ROBERT E. L. FOSTER, M.D., Phoenix, Arizona
DAVID I. FRYER, Sq. Ldr., RAF

ROBERT C. GAUDREAU, M.D., New Bedford, Mass.
RUSSELL W. GREENHALGH, M.D., Syracuse, New York
ERNEST P. GREENWOOD, M.D., Salem, Oregon
MORTON L. GUBIN, M.D., Memphis, Tennessee
FREDERICK E. GUEDRY, JR., Ph.D., Pensacola, Florida

STANFORD P. HAMPTON, M.D., Santa Rosa, California
HUGH H. HARKINS, Lt., USN
JOHN J. HAUGH, M.D., Milwaukee, Wisconsin
ROBERT C. HECKER, M.D., Washington, D. C.
EDWARD ALEX HEISE, M.D., Sumter, South Carolina
C. JULES HERITIER, M.D., Columbia City, Indiana
JOHN S. HERRING, M.D., Wilson Dam, Alabama
JAMES N. HILL, M.D., Colorado Springs, Colo.
ROBERT HITCHMAN, M.D., Des Moines, Washington
JAMES C. HODGE, M.D., Palos Verdes Estates, California
FRANCIS HOLLINGSWORTH, M.D., El Reno, Oklahoma
MICHAEL HOMA, M.D., Springfield, Virginia
MARTIN S. HONAN, M.D., Limerick, Ireland
SHIZUO HORI, Ph.D., Chicago, Illinois
JACK R. HUFFNER, Brinklow, Maryland
DWIGHT O. HUGHES, M.D., Fairbury, Nebraska
JOHN CALLOWAY HUNDLEY, M.D., Fort Stockton, Texas
LUCIUS L. HUTCHENS, M.D., Flora, Illinois

GEORGE N. IRVINE, JR., M.D., San Angelo, Texas

ALDIS A. JOHNSON, M.D., Anaheim, California
J. DON JOHNSON, M.D., Memphis, Tennessee
M. WILLIAM JOHNSON, M.D., Greenville, Ohio
FREDERICK A. JORDAN, M.D., Yuciapa, California

NEW MEMBERS

GEORGE E. KEHLER, Capt., USAF
 F. TYLER KELLY, M.D., Buffalo, New York
 GEORGE A. KERN, M.D., Des Moines, Iowa
 CHARLES B. KEY, M.D., Dallas, Texas
 RAYMOND R. KILLINGER, M.D., Jacksonville, Florida
 FRANCIS C. KING, M.D., Kirkwood, Missouri
 MARION D. KINZIE, M.D., Champaign, Illinois
 ROBERT DANA KNAPP, M.D., Wolf Point, Montana
 LEWIS J. KRAKAUER, M.D., Corvallis, Oregon
 ALBIN V. KWAK, M.D., Depew, New York

RALPH P. LAGONI, M.D., Eldridge, Iowa
 ROBERT ALLAN LAIDLAW, M.D., Northridge, California
 SAMUEL GEORGE LATTY, M.D., Winter Park, Florida
 JONES C. LAUGHLIN, M.D., Eagle Lake, Texas
 NICHOLAS LENTINI, M.D., Cheboygan, Michigan
 HARRY LEVINE, M.D., Fall River, Massachusetts
 CHARLES PELL LEWIS, JR., M.D., Reidsville, N. C.
 GEORGE N. LEWIS, M.D., Gary, Indiana
 CHAMP LIGON, M.D., Lexington, Kentucky
 JOHN C. LINDSAY, M.D., Ritzville, Washington
 BRUCE R. LITTLE, M.D., Santa Monica, California
 KENNETH M. LOGAN, M.D., Pittsburgh, Pennsylvania
 ROBERT F. LOIZZE, Lt. (jg), USNR
 GEORGE L. LOOMIS, M.D., Winona, Minnesota

G. AURELIO MEHEAN LOPEZ, M.D., Bolivia, South America

GEORGE G. LUCCHINA, Lt., USN
 STANLEY H. MACHT, M.D., Hagerstown, Maryland
 HOWARD H. MALDINER, M.D., North Tonawanda, New York

EDUARDO MEDINA MALDONADO, Capt., Mexican AF
 ROBERT L. MANNS, M.D., Pittsburgh, Pennsylvania
 HOMER D. MARTIN, M.D., Dailey, West Virginia
 JAMES E. MATTOX, M.D., Deadwood, South Dakota
 LAWRENCE MARYANOV, M.D., Cambridge, Maryland
 BERNARD WILLIAM MAYER, M.D., Allentown, Pa.
 DAVID A. MCCOY, M.D., Birmingham, Alabama
 WILLIAM F. MCCULLOUGH, M.D., Bottineau, N. D.
 FLOYD F. MCSPADEN, M.D., Houston, Texas
 WILLIS E. MEASE, M.D., Richlands, North Carolina
 BONNIE B. MENDITTO, Redondo Beach, California
 THOMAS TROUPE MESSENGER, M.D., Avenal, California
 EARL F. MILLER, II, Ph.D., Warrington, Florida
 MONTE B. MILLER, M.D., Garnett, Kansas
 JEAN N. MOADIE, M.D., Beirut, Lebanon
 MAX JAMES MOBLEY, M.D., Russellville, Arkansas
 EDWIN W. MOORE, Capt., USAF
 LOUIS S. MORGAN, M.D., Wichita, Kansas
 EDWARD D. MORTON, M.D., Tremonton, Utah
 ROBERT H. MOSER, Maj., USA
 HERBERT MULHOLLAND, M.D., New York, New York
 E. ADDIS MURRYAN, JR., M.D., New Orleans, Louisiana
 ERNEST E. MUSGRAVE, M.D., Jenkins, Kentucky

ROBERT H. NELSON, M.D., Benson, Minnesota
 NICHOLAAS J. NIEUWOUT, Maj., South African AF
 SAMUEL B. NUZIE, M.D., El Cajon, California

DANIEL J. O'CONNER, M.D., Forest Hills, New York
 ROBERT A. OLSON, M.D., Monterey Park, California
 SEAN O'QUIGLEY, M.D., Dublin, Ireland
 LOUIS B. OWENS, M.D., Cincinnati, Ohio
 D. E. OWENSBY, M.D., Tallassee, Alabama

SAM C. PASCOE, M.D., Falls Church, Virginia
 W. G. PARSEL, M.D., Costa Mesa, California
 ROBERT REX PETTEGREW, M.D., Leawood, Kansas
 WOODROW ELMER PHIPPS, M.D., Little Rock, Arkansas
 CARL S. PLUMB, M.D., Pisgah Forest, North Carolina
 EDMOND R. PLUNKETT, M.D., Barberton, Ohio
 ARTHUR C. PRIMROSE, M.D., Americus, Georgia
 ERVEN E. PUMALA, M.D., Warren, Minnesota

GEORGE MATHEW RAMAPURAM, M.D., Baltimore, Md.
 LEO B. RASMUISSEN, M.D., Vicksburg, Michigan
 ROBERT F. REED, M.D., Mishawaka, Indiana
 PAUL S. RICHARDS, M.D., Pasadena, California
 WILLIAM C. RICHLI, M.D., Colton, California
 MONROE RICHMAN, M.D., Sun Valley, California
 RICHARD O. ROGERS, JR., M.D., Bluefield, West Virginia
 CLARENCE R. ROGERO, M.D., Lantana, Florida
 LUCIA RONCHI ROSITANI, Ph.D., Florence, Italy
 JEROME J. RUBIN, M.D., Philadelphia, Pennsylvania

H. C. SCHARNWEBER, M.D., Glasgow, Montana
 GEORGE S. SCHWERIN, M.D., Chicago 49, Illinois
 HAROLD C. SELLE, M.D., Fort Lauderdale, Florida
 RAY L. SHEPPERD, M.D., Burnet, Texas
 ROBERT H. SHULER, M.D., Sitka, Alaska
 FRANKLIN D. SIDELL, M.D., Minneapolis, Minnesota
 NEILL SIMPSON, M.D., Waco, Texas
 JOHN M. SISSON, M.D., Detroit, Michigan
 JAY LELAND SITTERLEY, M.D., Flagstaff, Arizona
 ARTHUR H. SMITH, Ph.D., Davis, California
 HARRY SOHN, M.D., Floral Park, New York
 EDWARD V. STALZER, M.D., Chicago, Illinois
 A. C. STANDER, M.D., Saginaw, Michigan
 CHARLES E. STEVENS, M.D., Greenville, Michigan
 EDWIN L. STICKNEY, M.D., Miles City, Montana
 CLEMENT A. STIMSON, M.D., Petaluma, California
 EDWARD S. SUSNOW, M.D., San Francisco, California
 R. COURTNEY SUTTLE, M.D., Dallas, Texas
 H. R. SWIHART, M.D., Elkhart, Indiana

HORACE B. TAYLOR, M.D., Reno, Nevada
 H. H. THIBAUT, M.D., Los Gatos, California
 DONALD R. THOMAS, M.D., Delaware, Ohio
 GORDON G. THOMAS, M.D., Auburn, Washington
 PAUL H. THOROUGH, M.D., Lincoln, Nebraska
 DON C. TURNBULL, M.D., Birmingham, Alabama

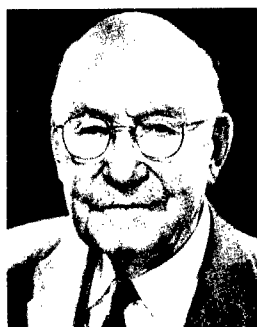
CHARLES W. UPP, Lt. Col., USAF

L. E. WANLESS, M.D., San Mateo, California
 W. P. WATKINS, M.D., Ranger, Texas
 EMERSON M. F. WEAVER, M.D., Los Angeles, California
 MAX HARRY WEIL, M.D., Los Angeles, California
 SANFORD L. WEILER, M.D., Harlan, Kentucky
 JAMES Y. WHITE, M.D., Bowman, South Carolina
 C. F. WIBLE, M.D., Sebewaing, Michigan
 ROY A. WILDEY, M.D., Bucyrus, Ohio
 JOHN A. WILHELM, M.D., Jacksonville, Florida
 WILLIAM M. WOOD, M.D., Carthage, Mississippi
 FLOYD L. WOOLCOTT, M.D., Lake Oswego, Oregon
 JAMES H. WOOTEN, M.D., Columbus, Texas
 JAMES G. WRIGHT, M.D., Sylacauga, Alabama
 ROBERT H. WRIGHT, M.D., Greensboro, Maryland

CLIFTON G. YORK, M.D., Lake City, Florida

In Memoriam

Walter L. Bierring, M.D., one of America's greatest medical leaders for over seventy years and a long-time friend to aviation medicine, died June 24, 1961, in Des Moines, Iowa. He would have been 93 years old July 15, 1961.



DOCTOR BIERRING

Dr. Bierring was elected an Honorary member of the Aerospace Medical Association in 1956. He made outstanding contributions to the success of the Association's prolonged efforts to establish aviation medicine as a specialty with American Board Certification. In his book "Doctors in the Sky," Dr. Robert J. Benford reports on the 1951 meeting of the Interim Board with a subcommittee of the American Board of Preventive Medicine and Public Health: "The meeting gained added significance by the presence of Dr. Walter L. Bierring, chairman of the American Board of Preventive Medicine and Public Health and an eminent figure in American medicine." "This meeting set the stage—Up until this time—little actual progress had been made. Now, with the wise and genial counsel of Dr. Bierring, coupled with the able and enthusiastic support of Dr. Stebbins, it appeared that the future was brighter than ever before for aviation medicine." Again Dr. Benford reports, "Under the wise and skillful chairmanship of Dr. Bierring, effective and convincing presentations were made before these groups—" i.e. Advisory Board for Medical Specialties and the AMA Council on Education and Hospitals. The *Journal of Aviation Medicine* reported it this way: "The epochal decision authorizing certification in aviation medicine—was forthcoming the following day and the task of the Interim Board was ended."

Dr. Bierring had four careers: In medical education at the University of Iowa (1893-1910) and Drake University (1910-13); In private (internal medicine) practice (1913-33); In public health, as Iowa state health commissioner (1933-53); As director of the Iowa Health Department's Division of Gerontology, Heart and Chronic Diseases, since 1953. Throughout his long career Dr. Bierring worked for organizations and programs designed to further medical education and professional standards.

In 1956 Dr. Bierring became the first past presi-

dent to receive AMA's Distinguished Service Award. He was made an honorary member of the Royal College of Physicians of Edinburgh in 1922. He was president of Alpha Omega Alpha, medical honor society, for 33 years.

Dr. Bierring helped form the American Board of Internal Medicine in 1936 and the American Board of Preventive Medicine and Public Health in 1947. He was on the National Board of Medical Examiners for 28 years and was secretary-treasurer of the Federation of State Medical Boards from 1912 to 1960.

Colonel Henry M. ("Mike") Sweeney, one of the Air Force's pioneers in aerospace medical research, died at USAF Hospital, Lackland, on July 11, 1961, following an illness. Col. Sweeney was Director of Medical Research at the USAF School of Aerospace Medicine from April, 1953, until his retirement in May, 1957. While at the school he was instrumental in initiating much of the present day space research now being done at the institute. He was one of those responsible for research into development of a closed ecological system to sustain astronauts in sealed space cabins. He approved the design and building of the world's first space cabin simulator.

Col. Sweeney won lasting eminence in aeromedical history early in World War II by proving the safety of flying in pressurized cabins without protection of pressure suits up to altitudes of 40,000 feet. In altitude chambers and in actual flights to extreme altitudes, Col. Sweeney personally demonstrated for the first time that man could survive explosive decompression at heights up to 40,000 if he immediately went on oxygen. In addition to extending the performance of World War II air crews in combat, this work paved the way for development of commercial air liners with pressurized cabins.

Col. Sweeney also pioneered in the testing and development of ejection seats, the life saving device now used in all high speed AF jets. He practiced the tradition—now a standard among aerospace medical researchers—of the scientist in charge of an experiment being the first human to try out any new development in his own project regardless of how hazardous it may be.

Col. Sweeney was one of the charter members of the Space Medicine Branch, Aerospace Medical Association, founded in 1951. He was born March 8, 1905, in Sutherland, Iowa. He received his B.S. and M.A. degrees at Iowa State University and his Ph.D. from Tulane University Medical School. Col.

In Memoriam (Continued)

Sweeney was an Instructor (1930-35) and later Assistant Professor (1935-37) in the Physiology Department of Tulane University. From 1937 to 42, he was Professor of Physiology and Head of the Department of Pharmacology of the School of Medicine at the University of South Dakota. In 1947, he became honorary associate Professor of Physiology at the Ohio State University School of Medicine. Col. Sweeney entered active duty in 1942.

* * *

The many friends of **Captain Lawrence W. Weber** were saddened by his untimely death as the result of an airplane accident in Wiesbaden, Germany, on May 19, 1961.



CAPTAIN WEBER

Captain Weber was trained as a pilot during World War II, completed his college education in Chemistry after the War, and returned to the USAF during the Korean crisis. A B-26 pilot, he flew fifty combat missions in Korea and returned to ATC as a flying instructor. He became associated with the Medical Service in 1954 when he was trained as an aviation physiologist. After outstanding work as a Physiological Training Officer in ATC and SAC he was assigned as Aviation Physiologist in the Aerospace Medicine Division, Office of the Surgeon General, Headquarters USAF, where he distinguished himself by meritorious service from June 1, 1956, to August 12, 1960, for which he received the Air Force Commendation Medal. His wife and four children reside in California.

Scientific Exhibits

The Scientific Exhibits Committee is eager to receive applications from exhibitors for the forthcoming meeting of the Aerospace Medical Association in Atlantic City, New Jersey, April 9-12, 1962. Scientific exhibits will be confined to the military services, other government agencies, universities, research institutes, and other non-profitable organizations. There will be no charge to the scientific exhibitors for floor space. Exhibitors in the military service and other government agencies will submit their applications through normal channels. Non-governmental exhibitors may apply direct to Colonel Frank M. Townsend, Chairman, Scientific Exhibits Committee, Aerospace Medical Association, Armed Forces Institute of Pathology, Washington 25, D. C.

COMING EVENTS

Sept. 23-24, 1961—Annual Meeting New Jersey Chapter Flying Physicians Association, Atlantic City, N. J. Chairman, J. L. Garofalo, M.D.

Sept. 26-30, 1961—International Congress of Aviation and Cosmonautical Medicine, Paris, France. President of the 10th European Congress is Professor R. Grandpierre. Communications regarding the Congress may be addressed to: General Secretary, 5 bis, Avenue de la Porte de Sevres, Paris XV°. Hotel reservations should be addressed to: Union Nationale des agences de Voyage, 18, Avenue de L'Opera, Paris, France.

Oct. 2-7, 1961—XIIth International Astronautical Congress, Washington, D. C. The International Astronautical Federation will be presided over by the President, Leonid I. Sedov (U.S.S.R.). Questions on the program of the Congress should be directed to: Professor Samuel Herrick, Chairman, XIIth International Astronautical Congress, University of California, Los Angeles 24, California, U.S.A. (See report of Bioastronautics Program on President's Page.)

Oct. 3, 4, 1961—21st Annual Congress on Occupational Health, Denver, Colorado, sponsored by AMA Council on Occupational Health and Colorado State Medical Society.

Oct. 9-15, 1961—Space Flight Report to the Nation, American Rocket Society, New York Coliseum, N. Y. C.

Oct. 17-19, 1961—Scientific Meeting of Joint Committee on Aviation Pathology, RCAF Institute of Aviation Medicine, Toronto, Ontario, Canada. Information: W/C D. O. Coons, RCAF, Canadian Joint Staff, 2450 Massachusetts Ave., Washington, D. C.

Oct. 30-Nov. 1, 1961—Aviation Medical Seminar, FAA, Emory University, Atlanta, Georgia.

Nov. 6-8, 1961—68th Annual Meeting Association of Military Surgeons, Mayflower Hotel, Washington, D. C.

Nov. 19-24, 1961—Conference on Medical and Biologic Problems in Space Flight, Nassau in the Bahamas. Information: I. I. Wechsler, P.O. Box 2454, Nassau, Bahamas. Included on the program are the following speakers: Dr. E. B. Konecni; Capt. Duane Graveline; Dr. R. B. Levine; Dr. C. Generales; Dr. Alan Brown; Dr. Carsbie Adams; Dr. A. Gib DeBusk; Dr. Carl Sagan and Dr. F. J. Ordway, III. Subjects include manned cabin systems, hypodynamic experiments, weightlessness, nutrition and space travel, neurospora, and others.

Special Announcement

An invitation is extended by the Scientific Program
Committee of the

Aerospace Medical Association

to those interested in participating as speakers in the
Scientific Sessions of the 33rd Annual Meeting
to be held at the

CHALFONTE-HADDON HALL

Atlantic City, New Jersey

April 9-12, 1962

All aspects of life sciences relevant to aerial and space flight will be considered appropriate topics for presentation. The sessions will include:

Research Reports

Development, Testing and Operational Applications

Clinical Aerospace Medicine

Abstracts, including title, name of author(s), degree or rank, and laboratory or office should be prepared and submitted as soon as possible. An original and one copy of the abstract are required not exceeding one double-spaced typewritten page in length. Abstracts should be sent to Captain C. P. Phoebus, Commanding Officer, U. S. Naval School of Aviation Medicine, U. S. Naval Aviation Medical Center—54, Pensacola, Florida, Chairman, Scientific Program Committee. Abstracts must be submitted prior to **December 1, 1961**, for review by the Scientific Program Committee, and should include a categorization by the author of the appropriate scientific field to which the paper is related, such as: acceleration, biophysics, physiology, bioastronautics, civil aviation, et cetera.

A résumé of the Scientific Program for the meeting will be published in the February issue, and abstracts of papers will be printed in the March issue of **Aerospace Medicine**.

Book Reviews

BASIC PHYSIOLOGY. By Fred E. D'Amour. The University of Chicago Press, 5750 Ellis Avenue, Chicago 37, Illinois, 1961. 642 pages, \$7.95.

It is seldom that a textbook manages to capture the full flavor of a great teacher's lectures, but this book holds all the liveliness that has made the author's classes a delight to hundreds of students. Dr. D'Amour's attitude has always been that it is his function to make his students love physiology, even—perhaps particularly—those students who take the course only to satisfy a curriculum requirement. The first words of the first chapter are: "This book is about you." Then, in what he admits is a frank attempt to arouse curiosity, the author promises to answer such intriguing questions as: "Can anything good be said of a tapeworm?" "The Sippy diet prescribes sips of what?" "If your gall bladder is infected, why does your right shoulder hurt?"

Many of the physiological matters that worry young adults are handled with tact and understanding. This is not, however, a predigested, science-at-a-glance text. The student is asked to think and to solve problems. Teachers will appreciate that this book contains so much more than just the bare bones of the subject and that it is completely up to date in its references to such topics as drugs and treatment of disease.

The structure of the book is such that it can be adapted to courses of varying lengths and intensity. It can serve as the sole basic text for biology and hygiene courses, and there are valuable leads to further research for those who are so inclined. Special mention should be made of the well-chosen illustrations, which are an integral part of the whole. This highly original text can be used at college, junior college or science-oriented high schools.

THE CHEMICAL PREVENTION OF CARDIAC NECROSES. By Hans Selye. The Ronald Press Company, 15 East 26th Street, New York 10, New York, 1958. 235 pages, \$9.00.

Cardiac necrosis is the most common cause of death in man. It may present itself in many forms, and most of its varieties are traditionally considered to be considered to be quite unrelated. The massive cardiac infarct caused by acute thrombosis of a coronary vessel surely appears to have little in common with such lesions as the necrotizing myocarditis of diphtheria, typhus or other infectious diseases, the "spotty myolysis" that occurs in certain viral infections, endomyo-

cardial fibrosis, hypokalemic cardiopathy, Fiedler's "isolated myocarditis," and the "nonspecific chronic myocarditis" that eventually develops in everybody who lives long enough. Indeed, it would be difficult to imagine a group of maladies more dissimilar than these as regards their etiology, clinical course, and morphologic characteristics. Yet, they all have one feature in common: necrosis of cardiac muscle fibers which are replaced first by inflammatory cells and eventually by scar tissue.

Many isolated clinical and experimental observations on cardiac necroses are now scattered throughout the world literature. One of the objects of this book was to coordinate these observations in the light of newly acquired knowledge about the electrolyte-steroid-cardiopathies. The book is comprehensive and contains all recent observations pertinent to the chemical production and prevention of cardiac necroses. The reader will find this volume a most stimulating book.

THE ETHICAL DILEMMA OF SCIENCE AND OTHER WRITINGS. By A. V. Hill. Oxford University Press, 417 Fifth Avenue, New York 16, New York, 1960. 395 pages, \$7.50.

A delightfully informal collection, this work contains writings and speeches from the long and distinguished career of the celebrated British physiologist and Nobel Laureate, A. V. Hill. Many of the articles are personal and most are nontechnical. Included are selections about the author's service to the British government during World Wars I and II, his years as a Member of Parliament from Cambridge, and his associations with scores of distinguished persons on both sides of the Atlantic and in India and Pakistan. The title of the book is taken from one of the articles which was originally Mr. Hill's presidential address to the British Association in 1952. It is, the author says, "The one which received more blame, and perhaps more approval, than the others."

Some kind of dilemma seems to be inherent in science, for every achievement, by its limitations, implies also a failure. The answer to a question generally raises a host of new questions, scientific, political, philosophical or ethical. At times, the dilemma becomes immensely practical as when reduction of death from disease fails to be accompanied by increased production of food, or when technological developments for warfare are not comprehended by political or military leaders. This unusual book is highly recommended.

AEOSPACE MEDICINE

BOOK REVIEWS

AEROSPACE YEAR BOOK. 1961 Edition. American Aviation Publications Inc., 1001 Vermont Avenue, N.W., Washington 5, D. C., 1961. 483 pages, \$10.00.

The twelve-month period reviewed in this volume was one of the intensely active periods on practically all aerospace fronts and the activity generated notable progress. In the field of space exploration, the gains were most impressive. Although the most spectacular space accomplishment of 1960, the recovery of live animals after orbit, fell to the Soviet Union, the breadth and scope of the United States program began to pay important dividends. As opposed to this single Soviet "first," American research teams recorded the first recovery of any object from space, the first communications satellites and the most distant radio transmission from space. The U. S. space programs, military and civilian, brought forth fourteen successful orbiting satellites during 1960, practically all of them of a more sophisticated nature than their predecessors. The Soviet Union orbited but two vehicles. At year-end, there were seventeen satellites in earth or solar orbits; fifteen of them were American. American prestige in the space exploration field reached its highest point since the start of the space age in 1957.

This book contains a complete pictorial review of the outstanding aerospace events of 1960. Photographs, specifications, and 3-view drawings of planes and engines currently in production are included as well as like data regarding status reports on all missiles in operation, production and development. The book is completely indexed and fully illustrated.

ELECTRICAL IMPEDANCE PLETHYSMOGRAPHY. By Jan Nyboer. Charles C Thomas, 301-327 East Lawrence Avenue, Springfield, Illinois, 1959. 245 pages, \$7.50.

In this book the author presents much material relating to electrical properties of the tissues. He describes a number of electrical methods that have been employed to study vascular phenomena, with particular emphasis on the technique he has used, and finally discusses the use of the impedance plethysmograph in the study of specific vascular phenomena. The book contains an experimental evaluation of electrical conduction of biological subjects in order to define "the academic and clinical role that measurements in electrical impedance to alternating current, such as a radio-frequency wave, may have in determination of the variations in fullness of the cardiovascular space pertinent to a segment, an organ, or the whole of the multicellular organism.

The volume is a forward biophysical look into electrical measurement in difficult places for obtaining the complex details of the volume pulse. It is an encouraging preview of data collected on volume and flow

changes observed under physiological conditions of measurement. The book points out that volume and flow observations derived from biologic conduction of electrical current serve to elucidate biophysical problems in general and animal physiology, especially hemodynamics at ambient, low, high, and space altitudes.

Acute, subacute, and chronic type of cardiovascular plethysmographic observations are all feasible without significant bloodletting or complex mechanical encapsulation of limbs or organs.

Quantitative pulsatile deviations may be studied continuously or intermittently in small or large segments of the body by the use of surface or implanted electrodes.

The author evolves theories on the nature of the volume-pulse and the nature of volume-flow as detected by injectable agents which vary the ionic concentrations in the blood. The number and distribution of ions determine the volume resistivities of the segments. A new and practical physical constant is introduced which clearly defines the "effective resistivity" of an injectable material.

This monograph will be of much interest to all biologists, pharmacologists, veterinarians and physicians in medicine and surgery.

New Books

THE CARDIAC ARRHYTHMIAS. By Brendan Phibbs. The C. V. Mosby Co., 3207 Washington Blvd., St. Louis 3, Missouri, 1961. 128 pages, \$7.50.

BLOOD AND OTHER BODY FLUIDS. Compiled by Philip L. Altman, edited by Dorothy S. Dittmer. Federation of American Societies for Experimental Biology, 9650 Wisconsin Avenue, Washington 14, D. C., 1961. 540 pages, \$10.00.

THE KYBERNETICS OF NATURAL SYSTEMS. By D. and K. Stanley-Jones. Pergamon Press Inc., 122 East 55th Street, New York 22, New York, 1960. 145 pages, \$6.50.

REILIEF OF SYMPTOMS (Second Edition). By Walter Modell. The C. V. Mosby Co., 3207 Washington Blvd., St. Louis 3, Missouri, 1961. 374 pages, \$11.50.

THE IMPACT OF THE NEW PHYSICS. By Frank Hinman. Philosophical Library, Inc., 15 East 40th Street, New York 16, New York, 1961. 174 pages, \$4.50.

Federal Aviation Agency Bureau of Aviation Medicine

Questions and Answers of Interest to Aviation Medical Examiners

Q.—If an applicant has been denied certification during the past twelve months, what procedure does the AME follow when the applicant reapplies?

A.—The Guide for Aviation Medical Examiners (Ch. III-4, 6) lists as one of the reasons for not issuing a certificate:

"If the applicant has been denied medical certification within the preceding twelve months, though he may appear to be physically qualified by your examination."

It has been shown that the twelve-months limit as stated above does not serve its purpose and as a consequence a change will be made in the new Guide.

In the interim, in all cases where the last examination resulted in a denial being issued, even though it has been longer than 12 months, complete the examination but do not issue the certificate. Refer the complete file to Washington for review. You will be advised as to the action taken.

Q.—How can an AME attend a seminar?

A.—Application to attend a seminar will be mailed by the Regional Flight Surgeon to AMEs within a 300 to 500 mile radius of where the seminar is to be held. If you receive an invitation to attend, fill out the application form and return it immediately to your Regional Flight Surgeon. Preference is given to newly appointed AMEs; acceptance is made on a first come, first serve basis. Therefore, if your application is accepted your Regional Flight Surgeon will notify you.

Q.—How long does it take after an aviation medical examiner has been appointed for his name to be placed in the "List of Aviation Medical Examiners?"

A.—The "List of Aviation Medical Examiners" now is published every two months. The AME who, for instance, was appointed September 10, 1961, should find his name listed in the November issue. A full two months is needed because of publication, proof-reading, and printing procedures. The September appointee's certification came too late in the month to have his name included in the September listing.

Q.—How can a physician find out about employment with the Aviation Medical Service of the Federal Aviation Agency and where are these positions located?

A.—A physician interested in employment with the Aviation Medical Service of the Federal Aviation Agency may write to the Civil Air Surgeon, Washington 25, D. C. At present, positions are available in Los Angeles, California, Ft. Worth, Texas, New York, New York, Atlanta, Georgia, Anchorage, Alaska, Washington, D. C., and at the Civil Aeromedical Research Institute in Oklahoma City, Oklahoma.

Q.—We have had many questions about our aviation medical seminars. To date, 9 have been conducted with 601 AMEs attending. Listed below are firm dates for future seminars.

A.—Seminars to be held in 1961:

August 16, 17, and 18—Texas Medical Center, Houston, Texas

August 23, 24, and 25—University of Oklahoma

September 27, 28, and 29—University of Nebraska

October 16, 17, and 18—University of Pennsylvania

October 30, 31, and Nov. 1—Emory University, Georgia

November 13, 14, and 15—University of Miami, Florida

November 29, 30, and Dec. 1—Mayo Clinic, Rochester, Minnesota

December 11, 12, and 13—University of Texas

To be held in 1962

January 17, 18, and 19—University of Kansas

February 14, 15, and 16—Lovelace Clinic, Albuquerque, New Mexico

February 28, March 1, and 2—University of Indiana

March 14, 15, and 16—UCLA, Los Angeles, California

May 23, 24, and 25—University of California

Q.—Of the total AMEs appointed, what percentage are general practitioners, ophthalmologists, internists, et cetera?

A.—As of April 1, 1961, the breakdown of AMEs by specialty is as follows:

| | |
|----------------------------|-----|
| General Practitioner | 52% |
| Internist | 15% |
| Surgeon | 13% |
| Ophthalmologist | 11% |
| Miscellaneous | 7% |
| Aviation Medicine | 2% |

Aerospace Medicine

Abstracts of Current Literature

Prepared under the Direction of ARNOLD J. JACOBUS, Ph.D.

For the reader's convenience, papers are classified by their principal contents into thirteen broad categories. Readers are advised to consult all related categories for full coverage of their field.

Biology

602

The Origin of Life on Earth and Elsewhere.

M. CALVIN. *Annals Internal Med.*, 54 (5):954-976. May 1961.

A description is given of the random synthesis of amino acids, formic and acetic acid, purines, pyrimidines, and other organic molecules from methane, ammonia, water, and hydrogen through the use of high energy ionizing radiation, ultraviolet light, or electrical discharges. Orderly and systematic interaction of these molecules, which present the metabolites and structural elements of living organisms, are attributed to the forces of autocatalysis and crystallization. Points of contact between laboratory findings and theoretical explanation of the construction of macromolecules are discussed. Studies in colloidal surface chemistry are needed to throw light on cell construction. A description is given of examinations on the organic constituents of meteorites and comets (as shown by light emission) designed to detect the presence of prebiotic organic synthesis on other planets. (25 references)

From the Science and Technology Division, Library of Congress, Washington, D.C. Dr. Jacobus is senior editor of *Aerospace Medicine: An Annotated Bibliography* (formerly *Aviation Medicine*). Volume II (1953 literature), published by the Aerospace Medical Association is available from Bruce Publishing Company, 2642 University Avenue, Saint Paul 14, Minnesota. Volumes I, III and IV can be purchased from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.

Publication of Current Abstracts is supported by the U. S. Federal Aviation Agency, the U. S. Department of Defense and the National Aeronautics and Space Administration.

SEPTEMBER, 1961

Physiology (General)

603

Intermittent Muscular Work. I. ÅSTRAND, P. O.

ÅSTRAND, E. H. CHRISTENSEN, and R. HEDMAN.—*Acta physiologica scandinavica* (Stockholm), 48 (4):448-453. 1960. In English.

The physiological effect of rest pauses on a non-steady-state work (2,160 kgm./min.) was studied. A physically well trained subject performed in one hour a total amount of 64,800 kgm. on a bicycle ergometer by intermittent work with 0.5, 1, 2 or 3 min. periods of work and rest. Total O₂ intake, total pulmonary ventilation, total number of heart beats and blood lactic acid concentration during the work hour and during recovery were determined. It was found that the heavy work, when split into short periods of work and rest (of 0.5 or 1 min. duration), was transformed to a submaximal load on circulation and respiration and was well tolerated during one hour. With longer periods (of 2 or 3 min. duration) the work output closely approached the upper limit of performance and could be fulfilled only with the utmost strain. These findings are discussed from a physiological and practical point of view. In order to explain the low lactic acid values during the short periods of work and rest it was proposed that the myohemoglobin has an important function as an oxygen store during short spells of heavy muscular work. (Authors' abstract)

604

The Influence of Rest Pauses on Mechanical Efficiency. E. H. CHRISTENSEN, R. HEDMAN and I. HOLMDAHL.—

Acta physiologica scandinavica (Stockholm), 48 (4):443-447. 1960. In English.

Two subjects performed a given quantity of work on a Krogh bicycle ergometer within one hour. With a relatively low load, the work was continuous, with higher loads, breaks of varied length and periodicity were introduced. Mechanical efficiency was the same or slightly less when continuous work was replaced by discontinuous work. (Authors' abstract)

877

605

Circulatory System in Positive Pressure Breathing (Układ krążenia w nadciśnieniu oddychowym). Z. JETHON.—*Lekarz wojskowy* (Warszawa), 36 (5):507-514. 1960. In Polish, with French summary. (p. 514).

Positive pressure breathing is used in the event of aircraft cabin damage at high altitudes. This method of increasing the partial oxygen pressure in the air of the pulmonary alveoli may lead to serious disorders of the circulatory and respiratory apparatus. In analyzing the hemodynamic and respiratory changes in pressure breathing, the mechanism of action of high altitude suits and the disorders produced during the compensation of pressure breathing by these suits are discussed. (Author's summary, modified) (23 references)

606

Human Performance as a Function of the Work-Rest Cycle: A Review of Selected Studies. J. T. RAY, O. E. MARTIN and E. A. ALLUISI.—*Nat. Acad. Sci.—Nat. Research Council*, Washington, D. C. Publication no. 882, 1961. viii + 32 p.

Within broad limits, performance does not appear to vary significantly as a function of the work-rest cycle, provided the work-rest and sleep-wakefulness ratios are held constant and the period of observation does not exceed one week. An exception is the decrement commonly observed in the performance of certain watchkeeping or vigilance tasks. Man is apparently capable of maintaining high-level performances on various tasks while living according to rather rigorous, atypical work-rest schedules, at least for short intervals of time. It may be postulated, however, that in many experiments various adaptive and motivational factors might be preventing the occurrence of differences in performance, especially under the conditions of short-term study. If performance is to be measured effectively, tests should be administered under realistic work situations which measure not only performance, but also such derived factors as motivation, learning, and skill. (From the authors' summary and conclusions) (76 references)

607

War Office Clothing and Equipment Physiological Research Establishment. E. T. RENBOURN and H. C. W. STOCKBRIDGE.—*Ergonomics* (London), 4 (1):73-79. Jan. 1961.

The history of the Establishment, and the nature of the researches undertaken are briefly reviewed. An account of past work follows which describes problems of the soldier's load, his working environment, his clothing and protective equipment, and the design of the fighting vehicles or guided weapon systems he may have to operate. (Authors' abstract)

608

Electrocardiograms by Telemetry. T. WINSOR, E. A. SIBLEY and E. K. FISHER.—*Calif. Med.*, 94 (5):284-286. May 1961.

The advantages and disadvantages of radiocardiography as compared with the electrocardiographic methods conventionally employed are described. Similarity of electrocardiograms and radiocardiograms has been demonstrated by making tracings simultaneously. The radiocardiographic method is especially suited for recording electrocardiograms during exercise and has the advantage of versatility, simplicity, freedom of movement for the patient, and high amplitude. Difficulties are sometimes encountered in interpreting the significance of the S-T segment shifts. Radiocardiograms may be transmitted with other physiological data to a medical reduction center for immediate interpretation or storage and later analysis.

Physiology of Stresses

609

Morphological Examination of the Effect of Rapid Changes of Atmospheric Pressure on the Animal Body (Badania morfologiczne nad wpływem nagłych zmian ciśnienia na ustrój zwierzęcia). S. BARANSKI and J. SZAMBORSKI.—*Lekarz wojskowy* (Warszawa), 36 (5):475-490. 1960. In Polish, with French summary. (p. 490).

A histopathological examination was made of the tissue from 60 rats subjected to explosive decompression. Damage caused by changes of atmospheric pressure was found chiefly in pulmonary tissue (hemorrhage, alveolar rupture, emphysema, atelectasis, edema). The liver, spleen, and adrenal glands demonstrated significant hyperemia. Histochemical tests for adrenaline content in the adrenal glands showed major differences between experimental and control animals, the former exhibiting weak reactions. The hematopoietic system did not react to explosive decompression of short duration, but after long duration an increase was observed in erythrocyte number, hemoglobin level, and hematocrit index. (Authors' summary, modified) (28 references)

610

Effect of Vitamin B₁₂ on the Resistance to Experimental Hypoxia and on Relative Hepatosis (Azione della vitamina B₁₂ sulla resistenza all'ipossia sperimentale e sulla epatosi relativa). G. BENZI.—*Il farmaco* (Pavia), 16 (3):144-151. March 1961. In Italian, with English summary. (p. 144).

Mice given an intraperitoneal injection of vitamin B₁₂, decompressed to 200 mm./Hg in ten minutes and kept at that level for 45 minutes exhibited the same convulsive symptoms and fatal outcome as the control

animals. Histopathological examinations demonstrated that vitamin B₁₂ was capable of decreasing the intensity of hypoxic hepatic steatosis. Quantitative chemical determinations of total hepatic lipids showed a statistically important decrease in the lipid content of treated animals in comparison with the controls. (45 references)

611

Effects of Hypercapnia on Retinal Arterial Pressure (Effets de l'hypercapnée sur la tension artérielle rétinienne). A. BOTTONI and A. BELLUSCHI. —*Annales d'oculistique* (Paris), 194 (4):320-327. April 1961. In French, with English summary. (p. 327).

A constant increase in retinal arterial blood pressure was found in subjects breathing a mixture of air containing 5% carbon dioxide. This phenomenon was possibly due to the vasodilatory effect of carbon dioxide on the cerebral and retinal blood vessels.

612

Relationship Between Body Fat and Shivering in Air at 15° C. F. DANIELS and P. T. BAKER. —*Jour. Applied Physiol.*, 16 (3):421-425. May 1961.

Thirty-one men of widely varying body fat content were exposed to air at 15.2° C. for 2 hrs. Rectal and skin temperatures and metabolic rates were measured at 10, 40, and 80 min. and at the end of the 2 hr. Shivering was rated on a five-interval scale. Under these conditions thick subcutaneous fat provided insulation as indicated by lower skin temperatures, less shivering, and lower oxygen consumption in the fatter men. The findings rule out simple relationships between measured temperatures and shivering, leading to other possibilities and approaches to the study of shivering. (Authors' abstract)

613

Chamber Cold Acclimatization in Man. T. R. A. DAVIS. —Army Medical Research Lab., Fort Knox, Ky. (USAMRL Project no. 6X64-12-001-01). Report no. 475, May 19, 1961. ii+8 p.

Unclassified

Nude subjects were exposed 8 hr. daily for 31 days to a temperature of 11.8° C. during March. Other subjects were acclimatized similarly to a temperature of 13.5° C. in September. At intervals during the exposures, measurements were made of shivering, O₂ consumption, and rectal and skin temperatures during a 2-hr. cold exposure. Shivering decreased significantly in both groups by the 14th day; heat production was unchanged in the winter group, but decreased significantly in the summer group. BMR did not change in either group. Rectal temperature in both groups was unchanged for 10 days, but decreased after the 14th day. On the basis of shivering

and rectal temperature changes, it was concluded that man can be artificially acclimatized. Failure of cold-elevated metabolism to decrease in the face of significant decrease in shivering indicates the presence of nonshivering thermogenesis in man. (Author's abstract) (20 references)

614

The Respiratory and Cardiovascular Response to Immersion in Cold and Warm Water.

M. EVANS. —*Quart. Jour. Exper. Physiol.* (London), 46 (1):83-94. Jan. 1961.

During their first few minutes of immersion in stirred water at 5° and 15° C., the pulmonary ventilation of twelve unclothed men was high, and their end-tidal carbon dioxide tension fell. The carbon dioxide tension then returned to or a little above its original level but did not greatly exceed it even in working experiments lasting 20 minutes in water at 5° C. or 40 minutes in water at 15° C. In water at 37.8° C. the men's heart rates rose steadily, in water at 25° C. they fell and remained low, and in water at 5° and 15° C. they rose and then fell. Repeated immersion at 15° C. reduced or abolished the entire respiration and heart rate responses to immersion and the metabolic response, but did not significantly increase the falls in rectal temperature. Clothing also reduced the reflex responses to immersion. A number of ventricular extrasystoles were observed during the first 2 minutes of immersion in water at 15° C., and it is suggested that ventricular fibrillation due to increased venous and arterial pressures, adrenaline, and hyperventilation, may be responsible for some cases of sudden death in cold water. (From the author's summary) (32 references)

615

Red Cell and Plasma Volumes of the Rat and of Tissues During Cold Acclimation.

N. B. EVERETT and L. MATSON. —*Jour. Applied Physiol.*, 16 (3):557-561. May 1961.

Red cell and plasma volumes of the total rat and of its individual tissues and organs were determined for animals exposed to 5° C. for 4 hrs., 2 weeks, and 6 weeks. In addition, the tissue hematocrit ratios were determined. These values were compared with those of rats kept at 24° C. Fe⁵⁹-labeled erythrocytes and I¹³¹-labeled albumin were given intravenously, and after mixing, the rats were frozen in liquid nitrogen. The organs and tissues were removed in the frozen state, assayed for radioactivity, and blood cell and plasma volumes were calculated on a unit weight basis. Significant changes in blood cell and plasma volumes were observed for the total rat and for many of the individual organs. There was a significant increase in the red cell content of the total rat within 24 hr. of

cold exposure. After 6 weeks, total blood volume was increased by approximately 20 per cent over the control level and the increase in erythrocyte volume was slightly more than the increase in plasma volume. The hematocrit ratio of heart blood was 44.8 after 6 weeks exposure compared with 41.5 for controls. In general, it can be said that the somatic parts of the body showed increases in blood volume whereas the visceral parts had decreased volumes. (Authors' abstract)

616

Effect of Propylthiouracil Treatment and Adrenalectomy on Heat Production and Heat Loss During Acute Exposure to Cold.

M. J. FREGLY, P. F. IAMPETRO and A. B. OTIS.—School of Aviation Medicine, Brooks Air Force Base, Tex. Report no. 61-46, April 1961. 9 p.

Unclassified

Thyroidectomy (propylthiouracil treatment) and adrenalectomy increased the rate of cooling of rats restrained and subjected to air at 5° C. At the same colonic temperature during cooling, both thyroidectomized and adrenalectomized rats maintained higher skin temperatures than did control rats. Heat production (measured by oxygen consumption) was determined for thyroidectomized and control rats only. At the same colonic temperatures during cooling thyroidectomized rats had the same heat production as controls. Calculation of heat loss at a given colonic temperature during cooling, however, revealed it to be greater for thyroidectomized than for control rats. The inability of thyroidectomized rats to tolerate cold as well as the control rats did under these conditions is due almost entirely to a more rapid loss of body heat. Failure to conserve heat may be related to changes in vascular reactivity induced by the hypothyroid state. (Authors' abstract) (26 references)

617

Effects of Pupil Aperture and of the Time of Exposure on the Fatigue-Induced Variations of the Flicker Fusion Frequency.

E. GRANDJEAN and E. PERRET.—*Ergonomics* (London), 4 (1):17-23. Jan. 1961.

Changes in Flicker Fusion Frequency (CFF) following performance of a mental task were measured on seven subjects using both an artificial pupil and normal vision, in order to see if these changes are due to modification of the pupil aperture following mental fatigue. Variations of CFF following a mental task were also studied in relation to the duration of the measures needed to establish CFF. Thirdly, the influence of an interruption of the intermittent light between two measures of CFF was examined. The results show that (1) the artificial pupil lowered the CFF but did not influence its changes due to the men-

tal task; (2) lengthening the duration of measurement from 10 to 16 sec. lowered the CFF and partially masked the effect of mental fatigue; (3) the interruption of the intermittent light between two measures did not alter the CFF values significantly. Replication of the measures on different days revealed a significant practice effect in that the CFF rose on the second day. (Authors' abstract) (23 references)

618

Study of the Effect of Electromagnetic Fields of High Frequency on the Human Body

(Badania nad wpływem pola elektromagnetycznego wysokiej częstotliwości na ustrój ludzki). S. HADUCH, S. BARANSKI and P. CZERSKI.—*Lekarz wojskowy* (Warszawa), 36 (2):119-125. 1960. In Polish, with English summary. (p. 125).

The peripheral blood of young persons exposed to electromagnetic fields of high frequency exhibited eosinophilia with lymphocytosis, neutropenia, and monocytosis. Most of the subjects showed symptoms of insignificant hypochromic anemia. (Authors' summary, modified)

619

Thermal and Metabolic Responses of the Alacaluf Indians to Moderate Cold Exposure.

H. T. HAMMEL.—Univ. of Pennsylvania. Dept. of Physiology, Philadelphia (Contract AF 33 (616)-6306); issued by Wright Air Development Division. Aerospace Medical Division, Wright-Patterson Air Force Base, Ohio (Project no. 7163, Task no. 71820). WADD Technical Report no. 60-633, Dec. 1960. iv+44 p.

Unclassified

The oxygen consumption and body temperatures of nine adult, male Alacaluf Indians were measured while exposed to moderate cold for 8 hours. The metabolic rate of the average Indian was 60 per cent higher than the average BMR of the white man at the beginning of the night and fell only slightly throughout the night. A few bouts of shivering increased the metabolism in bursts during the night. When comparing the Alacaluf Indians with other ethnic groups exposed to the same tests, three patterns appear: (a) the unacclimatized white man starts his metabolic rate at a near basal level and increases it markedly as his body temperature falls, (b) the Central Australian aborigine starts with a metabolic rate near basal and slides slowly downward as his rectal and skin temperatures fall to a little lower values than the white man's, and (c) the Alacaluf Indian starts with a very high metabolic rate which declines slightly as the rectal temperature falls following the pattern of the white man, and the skin temperatures of the trunk fall a little more than the white man's while the foot temperature falls a little less. (Author's abstract)

620

Effect of Altitude on Endurance Running of *Peromyscus maniculatus*. R. J. HOCK.—*Jour. Applied Physiol.*, 16 (3):435-438. May 1961.

One subspecies of deer mouse (*Peromyscus maniculatus*) was distributed from the floor of Death Valley to the tops of California's highest peaks. Endurance studies were made on two populations from 4,000 and 12,470 ft., respectively, at the Owens Valley and Barcroft Laboratories of the White Mountain Research Station. Mice ran on a treadmill at a speed of 40 m./min. and an inclination of 50% (22.5 deg.). Studies were made in February and March, so all animals used were adults. The mean of 25 performances by valley mice was 15.8 min.; the mean of 22 performances by mountain mice was 7.5 min. The chief factor of difference between the two groups is in the reduced pO_2 of the mountain environment and consequent hypoxia at this altitude. However, customary ambient temperatures are quite different, although room temperatures in which the animals were kept were similar. Although there is a possible differential effect of the same ambient temperature on the two mice populations, it was not discernible within each population except possibly in those trials run at over 20° C. (Author's abstract)

621

Physiological Problems of Space Flight.

P. HOWARD.—*New Scientist* (London), 10 (231): 106-108. April 1961.

Major problems of manned space flight, primarily acceleration, weightlessness, and deceleration, are discussed. Most of the data of the physiological effects of acceleration (including tolerance to various directions in which it acts on the body, symptoms created, effects on the circulatory system of increasing its intensity, and how to increase tolerance to increased g-intensity by assuming various body and head positions) have come from centrifuge studies. Knowledge concerning such problems as feeding, drinking, and excreting waste products in the weightless state and the effects of weightlessness on the nervous system has been drawn from carefully controlled parabolic flights in which weightlessness has been produced for about 40 sec. Deceleration has exactly the same properties and physiological effects as acceleration, and the same precautions must be taken to avoid exceeding its limits of tolerance. A discussion dealing with ways of keeping within deceleration tolerance limits during re-entry is presented.

622

Prediction of Skin Temperature of Men in the Cold. P. F. IAMPIETRO.—*Jour. Applied Physiol.*, 16 (3):405-408. May 1961.

Skin temperatures of semi-nude men were measured

during 2-hr. exposures to various combinations of air temperature (90-25° F.) and wind velocities (> 1, 5, 10 m.p.h.). The data were used to derive an expression for the estimation of mean weighted skin temperature as a function of duration of exposure (up to 180 min.), air temperature (90 to -20° F.), and wind-speed (0-40 m.p.h.). A chart was also constructed for more rapid estimation of skin temperature. (Author's abstract)

623

Some Physiological Changes Accompanying Tetany Induced by Exposure to Hot, Wet Conditions. P. F. IAMPIETRO, M. MAGER and E. B. GREEN.—*Jour. Applied Physiol.*, 16 (3):409-412.

May 1961.

Twenty-seven men were exposed to various hot, wet conditions for a total of 87 experiments. Determinations were made of rectal temperature, heart rate, blood pH, and the concentrations of CO_2 , calcium, inorganic phosphorus, and protein in plasma. Symptoms ranging from tingling of extremities to carpopedal spasms were observed. The frequency and severity of symptoms were apparently not related to the absolute change in any of the blood constituents but rather to the rate of change. (Authors' abstract)

624

Measurement of Oxygen Tension on the Surface of the Cerebral Cortex of the Cat During Hyperoxia and Hypoxia. D. H. INGVAR, D. W. LÜBBERS and B. SIESJÖ.—*Acta physiologica scandinavica* (Stockholm), 48 (4):373-381.

1960. In English.

The oxygen tension on the surface of the intact cerebral cortex of the cat was recorded continuously by means of a membrane-covered platinum cathode. The stability of the electrode permitted an interpretation of results from different experiments in relative terms. The influence upon the cortical pO_2 of high and low oxygen concentrations in the inspired air was studied. In ordinary hyperoxia only a moderate increase of cortical pO_2 was found. In post-hypoxic hyperoxia the cortical values reached values about 3 times as high. The difference found is interpreted as due to so called reactive hyperemia in the post-hypoxic state. (Authors' abstract)

625

Considerations on the Aggravation of Fatigue Factors in French Commercial Airlines Crewmen (Considérations sur l'aggravation des facteurs de fatigue chez les équipages de l'aviation commerciale française volant sur appareils à réaction).

G. JUIN.—*Rivista di medicina aeronautica e spaziale* (Roma), 24 (1):29-43. Jan.-March 1961. In French, with English summary. (p. 42).

Fatigue in the crew of commercial jet aircraft is due to either physical or psychological factors. The former include hypoxia, abrupt temperature changes, accelerations, digestive disturbances, changes in physiological rhythm, vibrations, ultrasonics, etc. Among the psychological causes are continuous attention, frequent emotional stresses, rapid and repeated sensory stimulation, etc. Flight fatigue appears to be increased by the introduction of jets, making adaptation of the flyer to his occupation more difficult. (Author's summary, modified)

626

The Effect of Work and Clothing on the Maintenance of the Body Temperature in Water. W. R. KEATINGE.—*Quart. Jour. Exper. Physiol.* (London), 46 (1):69-82. Jan. 1961.

Twelve young naval ratings were repeatedly immersed in water at temperatures between 5° and 37.8° C. Their temperatures, both rectal and esophageal when measured, fell more rapidly when they worked than when they stayed still in water at 5° or 15° C. This was so whether the men worked as hard as possible or at a slower rate, whether they wore clothes or not, and whether or not the water (at 15°C.) was stirred when they were still. The fattest man suffered relatively small decreases in rectal temperature at both 5° and 15° C. whether he worked or was still. Work had no significant effect on the rectal temperatures of unclothed men in water at 25° C. and caused a rise in water at 35° C. Work had no important effect on the decreases in surface or mean temperature during 20-minute immersions at 5° and 15° C. when the men were unclothed and the water (in the still experiments) was stirred, but it increased the falls in mean temperature when the immersions lasted 40 minutes and increased both when the men were clothed. Clothing substantially reduced the decreases in both surface and deep temperature, particularly in water at 5° C. The effect was prolonged when the men were still, but when they worked it was relatively slight after the first few minutes. (Author's summary) (28 references)

627

Effect of Anoxia on Cochlear Potentials. T. KONISHI, R. A. BUTLER and C. FERNANDEZ.—*Jour. Acoust. Soc. Amer.*, 33 (3):349-356. March 1961.

The anterior inferior cerebellar artery of guinea pigs was occluded, thereby interrupting the blood supply to the cochlea. Durations of occlusion ranged from 1 through 60 min. Cochlear microphonics, summing potential, action potential, and endocochlear potential were recorded before, during, and subsequent to occlusion. The differential effect of anoxia

on the various potentials was observed as well as the appearance of the large negative dc potential in scala media as anoxia progressed. For the brief occlusion durations, the amplitudes of all potentials except cochlear microphonics became greater than normal soon after the blood supply returned. Even for the longer anoxic intervals, the summing potential and the endocochlear potential exhibited supernormality during the recovery process. (Authors' abstract)

628

Excretion of Catecholamines in Rats Exposed to Cold. J. LEDUC.—*Acta physiologica scandinavica* (Stockholm), 51 (1):94-95. Jan. 1961. In English.

Rats exposed to a temperature of +3° C. for one month showed an increase in noradrenaline excretion four times as high as that found in the control group maintained at room temperature. In the adrenal glands, adrenaline was reduced 25% after 24 hours in the cold, followed by an increase, which persisted as long as the rats were kept in the cold. Noradrenaline content showed no significant change. Adrenalectomized rats excreted as much noradrenaline as intact animals on exposure to cold. However, adrenaline output in urine, although significantly increased in the cold was lower than in the intact group. Since noradrenaline appears to derive from the adrenergic nerve endings, it is inferred that the sympathetic nervous system is involved in the metabolic response to cold exposure through the release of noradrenaline. Adrenaline appears to represent a second line of defense called forth when environmental conditions become more severe.

629

A New Stress Tolerance Test with Simultaneous Study of Physiological and Psychological Variables: A Preliminary Study. L. LEVI.—*Acta endocrinologica* (Copenhagen), 37 (1):38-44. May 1961. In English.

A stress tolerance test was administered to nineteen subjects divided on the basis of clinical criteria into a high stress-tolerance group and a low stress-tolerance group. The test required the sorting of 2000 steel balls of four sizes, differing by 0.8 mm., for an hour while subjected to noise stress, dazzling light, time stress, and critical comments. The low-tolerance group exhibited a significantly lower efficiency level on the task, more behavior disturbances, and more subjective discomfort. Both groups showed a significant increase of adrenaline output in urine followed by a significant fall below the initial values during the post-stress period. The difference between both groups was also significant. The low-tolerance group, in addition, had a significant rise in noradrenaline. The author concludes that the simultaneous

estimation of work capacity, behavior, and urinary adrenaline and noradrenaline outputs during a standardized stress test is a useful diagnostic aid in stress-tolerance evaluation.

630

Prolonged Hypothermia. F. J. LEWIS.—Northwestern Univ. Medical School, Chicago, Ill.; issued by School of Aviation Medicine, Brooks Air Force Base, Tex. Report no. 61-45, April 1961. 5 p.

Unclassified

An automatic control system was used to maintain the body temperature of dogs below 25° C. for 20 hours. Once this low temperature was reached no anesthesia other than hypothermia was required. Blood pressure and pulse rate remained low throughout the cooling periods and as time passed the hematocrit rose, plasma volume fell, pH fell, and venous oxygen saturation fell. Of the 98 dogs cooled in this fashion, 31 survived rewarming. A number of agents and medications have been used in trying to increase the survival rate. Best results were achieved with the most recent technic which features a number of small changes such as deeper anesthesia during induction of hypothermia. Reserpine also may have contributed to a higher survival rate. (Author's summary)

631

Life at High Altitudes. *Lancet* (London), 2 (7166):1434-1436. Dec. 31, 1960.

Repeated short exposures to real or simulated great altitudes and longer exposures to moderate altitudes (7,000 ft.) increase tolerance and hasten adaptation to life at 14,000-15,000 ft. The following physiological changes are noted when acclimatization is completed: increase in blood volume and viscosity, polycythemia, increased vascularity, decrease in peripheral resistance, right ventricular hypertrophy, lowered systolic and diastolic blood pressures, and constant moderate pulmonary hypertension. The mechanism producing polycythemia in residents at high altitudes is discussed, and a description is given of chronic mountain sickness, a condition which can be cured by removal of the patient to sea level.

632

Cardiopulmonary Response to Thermal Stress. T. P. K. LIM.—In: *Clinical Cardiopulmonary Physiology*, Second ed., p. 958-960. New York: Grune and Stratton, 1960.

Discussions are given on investigations concerned with cardiovascular, metabolic, and respiratory adjustments to various temperature stresses. In hot environments, excessive heat influx is counterbalanced by the enhanced heat dissipation mechanisms of cutaneous vasodilatation and perspiration, leading to an increased skin temperature and peripheral blood flow. In cold environments, cutaneous vasoconstriction followed by

drastically reduced skin temperature and peripheral blood flow reverses the trend observed in hot environments. The effects of temperature stresses on metabolism, total ventilation in normal, resting subjects, O₂ consumption, alveolar CO₂ and O₂ tensions, and arterial blood pH are described.

633

Thermal and Metabolic Responses of Men in the Antarctic to a Standard Cold Stress.

F. A. MILAN, R. W. ELSNER and K. RODAHL.—*Jour. Applied Physiol.*, 16 (3):401-404. May 1961.

Thermal and metabolic responses of eight male subjects exposed nude for 2 hrs. to a standard cold stress (17° ± 1.0° C. air temperature) were examined in the austral fall, winter, and spring at Little America in the Antarctic. Mean body, average skin and foot temperatures increased significantly after 3 months. Neither rectal nor finger temperatures were changed over the year. Although basal metabolic rates were unchanged, there was a significant decrease in the metabolic responses to the standard cold stress after 3 months in the Antarctic. It is suggested that these changes represent physiological adaptations to chronic cold. (Authors' abstract)

634

The Limiting Hand Skin Temperature for Unaffected Manual Performance in the Cold.

R. E. CLARK.—*Jour. Applied Psychol.*, 45 (3):193-194. June 1961.

The hands of 12 enlisted men were cooled to 55° F. and 60° F. surface temperature on different experimental days. Performance times to complete a standard knot-tying task were obtained when the subject's hands first reached the appropriate hand skin temperature, after 20 minutes' exposure at the criterion temperature, after 40 minutes' exposure, and after 60 minutes' exposure. It was found that performance was severely hindered when hand skin temperature fell to 55° F., and that performance decrements at this skin temperature level were increasing exponential functions of duration of exposure, becoming asymptotic after about 40 minutes' exposure. In contrast, performance at 60° F. hand skin temperature remained unaffected throughout the exposure period. (Author's summary)

635

Mice Impacted to Save Astronauts. H. M.

DAVID.—*Missiles and Rockets*, 8 (16):35. April 17, 1961.

Mice enclosed in plastic tubes and positioned so that they received the impact of the fall on their backs were loaded on a carriage and dropped to the bottom of an elevator shaft. Survival rates indicate that small, restrained animals can tolerate impact velocities of about 17-31 m.p.h. and decelerations of

650-1970 g. The tests gave evidence that animals receiving high g forces in the transverse position survive with the fewest injuries. Impact tolerance limit data will eventually be incorporated in the design of restraint and escape systems.

636

The Influence of Anoxia and Hypercapnia, Separately and in Combination, on Chemoreceptor Impulse Discharge [Abstract]. N. JOELS and E. NEIL.—*Jour. Physiol. (London)*, 155 (2):45P-46P. Feb. 1961.

The carotid body of a pentobarbitone-anesthetized cat was perfused with four solutions with equilibrated gas (O_2 and CO_2) tensions. The impulse activity aroused in the carotid sinus nerve in response to each of these perfusive fluids was recorded photographically. The chemoreceptor response to the combination of anoxia and hypercapnia greatly exceeded that which might have been expected from the arithmetic summation of the effects of either stimulus acting alone.

637

Changes in Muscular Efficiency during Work in Noise Conditions (Izmeneniia myshechnoi rabotosposobnosti pri rabote v usloviiakh vozdeistviia shuma.) E. P. ORLOVSKAIA.—*Gigiena i sanitariia* (Moskva), 26 (4):21-24. April 1961. In Russian, with English summary (p. 24).

Ergographic studies were made of muscular efficiency in 20 persons after 2 hours of dosed physical work performed under conditions of noise. The results were compared with those obtained in control tests of the same persons under normal conditions. In noise, the muscular efficiency was greatly decreased; in the control tests it remained at the same level as, or was higher than, before the work was started. During the experimental situation, one could note a decline of all muscular efficiency indices: the muscular force was decreased, resistance to fatigue was weakened, and feelings of exhaustion were intensified. It is suggested that the decrease of working capacity in noise may be mediated by a delay in the restoration process caused by the noise. (Author's summary, modified)

638

Simulated Space Flights. G. R. STEINKAMP and G. T. HAUTY.—In: *Psychophysiological Aspects of Space Flight*, p. 75-79. Ed. by B. E. Flaherty. New York: Columbia Univ. Press, 1961.

The physiological and psychological responses of selected subjects exposed to 30-hour test periods in a space cabin simulator are described. Conditions of the experiment included restricted diet, restriction of movement, and the requirement of constant attention to a flight task. During the test period all subjects experienced psychological aberrations of some kind and in

varying degree. Following exposure subjects exhibited the effects of accumulative fatigue, sleep deprivation, lowered caloric intake, and mild dehydration. The experiments indicate the need for pre-flight exposure to simulated space flight conditions and continued research with space cabin simulators.

639

Tissue Catecholamine Content of Cold-Acclimated Rats. K. E. MOORE, D. N. CALVERT and T. M. BRODY.—*Proc. Soc. Exper. Biol. and Med.*, 106 (4):816-818. April 1961.

Exposure of female rats to temperatures of 5-7° C. for 3-5 weeks resulted in hypertrophy of the liver, heart and kidney. In these rats the catecholamine content of the brain was unchanged, while that of the heart was reduced and in the adrenal increased. (Authors' summary)

640

Pulmonary Arterial Hyperoxia Producing Increased Pulmonary Vascular Resistance. P. V. MOULDER, J. R. LANCASTER, R. W. HARRISON, S. L. MICHEL, M. SNYDER and R. G. THOMPSON.—*Jour. Thoracic and Cardiovascular Surg.*, 40 (5): 588-601. Nov. 1960.

Observations with the use of a controlled extracorporeal shunt from venae cavae to right atrium in which the oxygenation of the blood, other than that returning by the coronary sinus, was controlled, showed an increased vascular resistance associated with the institution of the bypass circuits and a striking increase in all parameters related to increased total pulmonary resistance and pulmonary hypertension when excessively oxygenated blood was returned to the right side of the heart. The vascular reaction to oxygenated blood in the pulmonary circuit was lethal in some normal dogs. (Authors' summary, modified)

641

Evaluation of Human Subject Reaction in the Forward and Aft Facing Seated Positions. H. NOBLE and L. P. DOMZALSKI.—Naval Air Materiel Center. Air Crew Equipment Lab., Philadelphia, Pa. Report no. NAMC-ACEL-424, Feb. 9, 1961. vi+7 p. Unclassified

Tests were conducted on the linear accelerator using two male volunteers and anthropomorphic dummies representing the same percentile classes as the human subjects. Measurements of seat loading during acceleration were obtained, and acceleration and displacement of the accelerator sled, seats, and subjects were recorded on both the oscillograph and high speed motion picture films. Test studies revealed that the forward-facing occupant was not sufficiently restrained in the seat and his upper torso suffered ill effects

during the acceleration stroke. The aft-facing occupant was capable of withstanding greater accelerations, but the structural integrity of this seat under a particular load was not superior to its counterpart. Specific recommendations are given for structural modifications in both seats for use in military passenger aircraft.

642

Effect of Hypoxia or Plasma Erythropoietin in the Rabbit. T. C. PRENTICE and E. A. MIRAND. —*Proc. Soc. Exper. Biol. and Med.*, 106 (3):501-502. March 1961.

Plasma erythropoietin (EPF) levels were determined in rabbits which had been exposed for various time periods to ten per cent oxygen. A significant elevation of EPF levels was evident at eight hours. Peak levels were present at 24 and 48 hours. By 72 hours the level of EPF had returned to normal and remained there up to 120 hours. A similar response to hypoxic stimulus has been found in rats.

643

Glucose-Uptake and Insulin Sensitivity of the Epididymal Fat of the Rat After Exposure to Cold. J. L. R-CANDELA. —*Medicina experimentalis* (Basel), 3 (1):84-87. 1960. In English.

Rats exposed to cold (4° C.) for 1-12 days showed a reduced consumption of glucose in the epididymal fat after 1, 3, and 12 days, and an increased consumption after 6 days. The insulin sensitivity of the fat decreased after 1 and 3 days, increased considerably after 6 days, and returned to normal after 12 days. The results suggest the presence of hypophyseal-adrenal responses and inhibitions, which may in turn explain the hypoglycemia previously observed in rats exposed to cold.

644

Influence of Intermittent Exposure to Simulated Altitude on Plasma and Tissue Electrolytes in Rats. J. L. REEVES. —School of Aviation Medicine. Aerospace Medical Center, Brooks Air Force Base, Texas. Report no. 61-37, Feb. 1961. 20 p. Unclassified

Young adult rats exposed four hours each day to 380 mm. Hg barometric pressure in an altitude chamber for twenty-six to twenty-eight weeks exhibited changes in body weight, organ weight, hemoglobin, and hematocrit of the same order of magnitude as rats continuously exposed to the same conditions. Plasma cation concentration was not affected, but a substantial shift occurred in the relative concentrations of anions. With the exception of the ventricular myocardium, the electrolyte composition of soft tissues did not materially change. The femoral shaft, the most severely affected of the tissues, exhibited

depletion of calcium, phosphorus, and sodium and, at the same time, an accumulation of potassium. The decrease of bone electrolytes was in a ratio which indicated complete solution of the apatite crystal rather than anionic or cationic exchange reactions. Should these observations on bone dissolution and myocardial electrolyte shift be confirmed in rats and other species, the safety of altitude acclimatization by the means used in the study would be questioned. (Author's abstract) (36 references)

645

Circulatory Changes in Man During Mild Supine Exercise. J. T. REEVES, R. F. GROVER, G. G. F. FILLEY and S. G. BLOUNT. —*Jour. Applied Physiol.*, 16 (2):279-282. March 1961.

Cardiac output and femoral A-V oxygen difference were measured in each of seven normal men at rest and during several stints of supine exercise to investigate the mechanisms of oxygen transport for stepwise increments of oxygen uptake. The femoral A-V oxygen difference increased sharply for mild exercise and showed smaller further increase for heavier exercise stints. The pulmonary A-V oxygen difference followed a similar behavior where the changes were of smaller magnitude. For mild exercise, increasing oxygen transport apparently depends to a greater extent on increasing femoral tissue oxygen extraction and to a lesser extent on increased femoral and total blood flow. For heavier exertion, increasing oxygen transport depends to a greater extent on increasing flow and to a smaller extent on a widening tissue oxygen extraction. Mechanisms which are utilized to meet the increased metabolic demands of exercise depend in part upon the severity of the exertion. Cardiac output appears not to be a simple linear function of oxygen uptake for various metabolic demands ranging from rest to heavy exercise. (Authors' abstract)

646

Changes in Blood Flow and Temperature of Muscle in the Chilled Limb of the Rabbit. A. SAYEN and C. BOLAND. —*Clinical Sci.* (London), 20 (2):217-221. April 1961.

Venous occlusion plethysmography with the mercury strain gauge technique demonstrated that immersion of a limb in cold water at 2° C. results in a decrease in blood flow to the chilled muscle. Transient rises in temperature of chilled muscle are associated with motion of the limb and are accompanied by an increase in limb blood flow, probably occurring predominantly in muscle. (Authors' summary)

647

Altitude Physiology: Air Travel in the Jet Age. A. H. SCHWICHTENBERG, U. C. LUFT and K. L. STRATTON. —In: *Clinical cardiopulmonary physi-*

ology, Second ed., p. 936-957. New York: Grune and Stratton, 1960.

A brief chronological outline is given of man's achievements in flight. The nature of the environment at high altitudes and some of the physiological stresses which are encountered during high-altitude flight are described. Attention is given to the following aspects: the causes and manifestations of hypoxia, dysbarism, and explosive decompression; the effects of variations in gravity forces and the use of anti-g suits; turbulence and motion sickness; the control of temperature, humidity, and toxic contaminants in the pressurized cabin; the hazards of cosmic radiation and radioactivity; aircraft noise and levels of human tolerance to sound; altitude acclimatization; the effects of increased light intensity and glare; and altitude myopia. The relationship of various pathologic conditions to air transportability is also discussed. (32 references)

648

The Problems of Noise (Les problèmes du bruit).

C. S. SNEPVANGERS.—*Revue internationale des services de santé des armées de terre, de mer, et de l'air* (Paris), 34 (3):81-90. March 1961. In French, with English summary. (p. 81).

A discussion is presented on the nature and hazards of noise in general and jet engine noise (120-130 decibels) and B-47 noise (140 decibels) in particular. It is recommended that flying personnel exposed to engine noise for long periods of time be given pre-selection audiometry and periodic post-employment audiometry to evaluate hearing ability, and that personal protective equipment such as ear plugs and muffs be used.

649

Some Physiological Responses of Man to Workload and Environment.

C. W. SUGGS and W. E. SPLINTER.—*Jour. Applied Physiol.*, 16 (3): 413-420. May 1961.

The heart rate, ventilation rate, oxygen consumption rate, and mechanical efficiency responses of a subject to a series of temperatures, relative humidities, and workloads were observed. A quadratic prediction equation of each of the responses as steady-state functions of the independent variables was derived. Each of the equations represents a four-dimensional hypersurface. For the heart rate, ventilation rate, and oxygen consumption rate the hypersurfaces are quite similar, the responses increasing rapidly with respect to workload and about one-third as rapidly with respect to temperature. The effect of relative humidity was present primarily as interactions. Mechanical efficiency was represented by a more complex hypersurface. In three dimensions, with relative humidity as a parameter, the response was a saddle-shaped

surface with the highest efficiency at a condition of low temperature, high workload. At constant environment, the heart rate responses of 19 subjects to workloads was observed and found to be linear with a normal distribution of slopes. (Authors' abstract)

650

The Effect of Work Performed in Hypothermia and Hyperthermia on Pituitary-Adrenocortical Function.

T. L. YANG and E. ENDRÖCZI.—*Acta physiologica Academiae scientiarum hungaricae* (Budapest), 18 (2):131-136. 1960. In English.

Rats were made to swim in water of different temperatures in order to study the effect of complete exhaustion on the corticoid pattern of the adrenal venous blood and on hormone synthesis by adrenal tissue incubated *in vitro*. At optimum water temperature, swimming had practically no effect on corticosterone content, while swimming in water at 18° C. caused its reduction. On the other hand, aldosterone content increased markedly on swimming at 30°, 18° and 43° C., and was highest at the low environmental temperature. Compound X, invariably present in adrenal venous blood, behaved like corticosterone. (From the authors' summary)

Neuro- and Sensory Physiology

651

The Perception of Moving Objects. VI. The Practical Application in Aviation.

W. A. CRAWFORD.—RAF Institute of Aviation Med. (Gt. Brit.), Farnborough; issued by Flying Personnel Research Committee (Gt. Brit.). FPRC Memo no. 150.g, Sept. 1960. [8] p. Unclassified

Experimental research has demonstrated that three factors contribute to the ability to discriminate detail of moving objects: time available for viewing objects, angular velocity of object viewed, and natural co-ordinated use of the head and eyes. In normal flight the time available for viewing is generally long, the angular velocity low to moderate, and the head free to move. Variation in such discriminative ability is of little moment except in conditions of high-speed, low-level flight. Here, training may be of value. (Author's summary)

652

Convergence as a Cue to Absolute Distance.

W. C. GOGEL.—Army Medical Research Lab., Fort Knox, Ky. (USAMRL Project no. 6X95-25-001). Report no. 467, May 17, 1961. ii+16 p. Unclassified

The role of convergence and accommodation in the perception of absolute distance was investigated. Perceived absolute distance was measured by using a visual ruler consisting of a monocularly viewed alley.

The apparent distance of a binocular object was judged with respect to the monocular alley for convergence values of 4° or less. With accommodation held constant, only a few subjects perceived different distances for different convergence values. With both absolute accommodation and accommodative differences in agreement with convergence, the proportion of subjects who could make this discrimination increased. In general, the results indicate the inadequacy of convergence as a cue to perceived absolute distance for the range of convergence values used in this study. (Author's abstract)

653

Convergence as a Cue to the Perceived Distance of Objects in a Binocular Configuration. W. C. GOGEL.—Army Medical Research Lab., Fort Knox, Ky. (USAMRL Project no. 6X95-25-001-13). Report no. 468, May 18, 1961. ii+15 p. Unclassified

The perceived absolute distance of binocularly observed objects as a function of convergence was measured by having subjects judge the distance of the binocular objects with respect to a monocularly observed alley containing adequate distance cues. It was found that the ability to perceive changes in distance with convergence was not improved by using several rather than a single binocular object. Also, the relation between perceived distance and convergence for a binocular object when this did occur was not independent of the presence of the other binocular objects in the configuration. (Author's abstract)

654

Improved Method for Studying Tympanic Reflexes in Man. E. S. MENDELSON.—*Jour. Acoust. Soc. Amer.*, 33 (2):146-152. Feb. 1961.

Also issued as: Naval Air Material Center. Air Crew Equipment Lab., Philadelphia, Pa. Report no. NAMC-ACEL-457 (Report no. 5, of Auditory Reflex Reactions and Jet Engine Noise), May 19, 1961.

A description is given of a manometric apparatus developed for registering the involuntary displacements of the human tympanic membrane during the reflex contraction of the middle-ear muscles. Recent tests with the new method have been uniformly successful in 14 inexperienced subjects, as contrasted with only 20 out of 57 previously. The reflex reactions have also been recorded from subjects who have been judged nonreactors in previous tests. Extensive repetitions of tests on one subject have yielded a close quantitative relation between stimulus and response-index magnitudes. The stimulus was a click-free tone of 500 c.p.s., graded in steps of 1 db. The threshold sound pressure level was about 111 db., and response magnitude rose in sigmoid fashion with progressively stronger stimuli. This method has yielded empirical information relevant to the problems of individual noise tolerance, attenua-

tion of high-intensity sounds by ear protectors, recovery of normal physiological functions after induced hearing loss, and conditions favoring continuous contraction of the middle-ear muscles.

655

Physiological Limits for "Subliminal" Perception. M. SCHWARTZ and C. SHAGASS.—*Science* (Washington), 133 (3457):1017-1018. March 31, 1961.

Cortical, subcortical, and peripheral sensory nerve potentials were studied in cats to determine comparative thresholds of response. Stimuli capable of eliciting responses in peripheral nerve also invariably elicited responses from thalamus and cortex. Together with relevant data from human studies, the results indicate that stimuli subthreshold for perception do not affect the nervous system. They also have implications for studies of "subliminal" perception. (Authors' abstract)

656

Some Immediate Effects of Drowsiness and Sleep on Normal Human Performance.

C. W. SIMON.—*Human Factors*, 3 (1):1-17. March 1961.

Man spends the greater portion of his life in sub-optimum states of consciousness. The paper reviews the experimental literature describing normal human performance at different levels of drowsiness and sleep, as these states are defined by electroencephalographic patterns. Among the types of behavioral responses to stimuli discussed are reflexes, simple movements, detection (i.e., arousal to external stimuli and awareness of internal states), discrimination, learning, and recall. Non-behavioral electroencephalographic responses are also described. Suggestions are made for future research. (Author's abstract) (34 references)

Psychology

657

An Experimental Investigation of the Interaction Between Problem Load and Level of Training. R. A. BEHAN, C. R. BUGHMAN, J. N. BUMPUS and S. GILBERT.—*Human Factors*, 3 (1):

53-59. March 1961.

An experiment was made to determine the relation between performance in a linear information processing system, level of training, and the input load on the system. Level of training was determined by number of problem experiences. Load was defined as the number of task units to be processed. The task was to detect, display, transform, re-display and correlate data concerning the temporal position and direction of sequences displayed on a rectangular grid. Two noise dots were included with each display presentation. Experimental variables were presented in a mixed

factorial design. Experimental problems had a constant number of sequences to be processed after a short build-up period. The sequences in any one problem appeared at regular intervals and all had the same time duration. Four experimental problems presented 2, 4, 8 or 12 sequences to the subjects. Analysis of total error indicated that performance is a linear function of load, and that an interaction between total error and system position resulted in no significant reduction in error as a function of training. (Authors' abstract)

658

Psychological Problems of Flight (Problemele psihologice ale zborului). V. CEAUSU.—*Revista de psihologie* (Bucuresti), 6 (3):95-114. 1960. In Rumanian, with French summary. (p. 113).

The principal problems of aviation psychology are reviewed in the light of modern flight techniques. Three aspects of pilot activity have been distinguished by psychological analysis: (1) information input; (2) reaction or response to information; and (3) self-induced control or control through feedback of information related to previous activity. These aspects are viewed in relationship to the psychological effects of altitude, speed, and accelerations encountered during flight. To determine the psychological requirements for a pilot, flight performance analysis should include a study of general aptitudes and of adaptation and non-adaptation during the training period. Discussions of the problems of improving equipment as well as selection and training of aviation personnel on the basis of psychological criteria are included. (Author's summary, translated and modified)

659

Influence of Psychodynamic Factors on Central Nervous System Functioning in Young and Aged Subjects. S. I. COHEN, A. J. SILVERMAN and B. M. SHMAVONIAN.—*Psychosomatic Med.*, 23 (2):123-137. March-April 1961.

Ten young and ten old subjects (matched for IQ and for physical and mental health) were presented pure tones, neutral phrases, and phrases "charged" for each age group, while continuous GSR (skin-resistance) recordings were obtained as a measure of central nervous system activity. The subjects were interviewed to evaluate their degree of "memory" for the experiment and their perception of the meaning of and affective response to the test situation and stimuli. The findings did not allow any definite formulations regarding young and aged individuals. The results indicated that studies assessing perceptual and cognitive functions should take into consideration the influence of: (1) reception and conduction of specific sensory inputs; (2) the level of non-specific CNS activation; and (3) the psychological adaptive

mechanisms activated by the psychodynamic implications of the experimental stimuli and the emotional arousal produced. (24 references)

660

The Effect of "Unwanted" Signals on Performance in a Vigilance Task. W. P. COLQUHOUN.—*Ergonomics* (London), 4 (1):41-51. Jan. 1961.

Performance in a task of visual vigilance in which both "wanted" and "unwanted" signals occurred was observed in an experiment in which signal frequency and wanted signal probability (ratio of wanted to unwanted signals) were varied independently. It was found that: (1) A sixfold increase in the probability that any signal occurring would be a wanted one resulted in a considerable improvement in the efficiency with which these wanted signals were detected, whereas a similar increase in the frequency with which signals were presented produced no significant alteration in efficiency. (2) The improvement in performance appeared during the first ten minutes of the watch and remained in evidence throughout the session. (3) The improvement was most marked in the case of signals appearing near the periphery of the display. (4) Individual differences in detection efficiency were related to the frequency with which false reports were made. Implications for the theory of vigilance behavior, and the relevance of the results to the organization of monitoring work, are considered in the discussion. (Author's abstract)

661

Psychological Problems of Space Flight. K. G. CORKINDALE.—*New Scientist* (London), 10 (236):457-459. May 23, 1961.

The effects of the following psychological stresses on performance and behavior of the astronaut are summarized: high g forces, weightlessness, isolation, restraint, and sensory deprivation.

Medical Problems

662

Pulmonary Edema of High Altitude. V. ALZAMORA-CASTRO, G. GARRIDO-LECCA and G. BATTILANA.—*Amer. Jour. Cardiol.*, 7 (6):769-778. June 1961.

Acute pulmonary edema produced by exposure to altitudes of 3,000 m. or higher was observed in twenty-seven subjects with normal hearts, ranging in age from four years to fifty-three years. The disease was often observed in acclimatized subjects returning to high altitudes after short visits to places located at sea level. As a rule symptoms appeared shortly after arrival at the high elevation, either during the first trip or in one or more subsequent trips. Respiratory infections were an aggravating or precipitating factor.

The recommended treatment is oxygen, or when possible, descent to lower altitudes or sea level. The mechanism responsible for high-altitude pulmonary edema is not clear, but various possible causes are discussed briefly. (20 references)

663

Contraindications of Certain Drugs for Aircraft Pilots and Automobile Drivers

(Contre-indications de certain médicaments pour les pilotes d'avions et les conducteurs de véhicules automobiles). E. EVRARD.—*Bruxelles-médical* (Bruxelles), 40 (7):215-221. Feb. 14, 1961. In French, with English summary. (p. 221).

Drugs which cause changes in the nervous system and in psychomotor responses are sources of danger for flight safety. Certain antihistaminics, nasal decongestants, anti-malarials, atropine-scopolamine preparations, antibiotics, sulfonamides, stimulants (benzedrine, caffeine, etc.), and tranquilizing agents are contraindicated for use by pilots or are to be used with caution.

664

A New Occupational Medicine: Aviation Medicine in the Jet Age (Une nouvelle médecine du travail: la médecine du travail aérien à l'ère des réacteurs). G. JUIN.—In: *Proc. of 13th International Congress on Occupational Health* [New York], July 25-29, 1960, p. 942-947. In French. New York: Book Craftsmen Association, Inc., 1960.

Jet aircraft personnel are exposed to many physiological hazards, such as anoxia, high speed and high altitude, decompression, positive and negative accelerations, vibration, climatic changes, and the wearing of cumbersome clothing. In addition, jet flight is associated with changes in normal physiological rhythms affecting sleep patterns, hours of rest, body temperature, cardiovascular and respiratory equilibrium, and digestive functions (changes in hunger sensations, types of meals). Therefore, a great number of jet personnel are suffering from flight fatigue and gastrointestinal disorders (severe colitis, gastritis, gastroduodenal ulcers). Exposures to ultrasonic rays affect the nervous, muscular, cardiovascular, intestinal, and endocrine systems. Mention is made of the psychological factors (tension, anxiety, emotion) related to jet flight, and recommendations are made for the extensive medical examination of jet personnel.

Personnel

665

Survey of Escape Training in the Air Force.

M. BEER, R. M. JAYSON, V. E. CARTER, and F. H. KRESSE.—Wright Air Development Division. Aero-

space Medical Lab., Behavioral Sciences Lab., Wright-Patterson Air Force Base, Ohio (Project no. 7222, Task no. 71748). WADD Technical Report no. 60-792, March 1961. iv+71 p. Unclassified

The present state of the Air Force ejection training was studied and its contribution to the overall ejection problem was considered. Relevant information was obtained from the literature on ejection training, training films, aircrew personnel, aircrew personnel who have ejected, accident statistics, and escape training instructors. The results showed that ejection training is inadequate in content and frequency. There is a lack of standardized regular training programs. Furthermore, training media, such as ejection seat trainers and films, leave much to be desired in both quantity and quality. Even more important, training to reduce fear of and anxiety about ejection is needed. In general, aircrew personnel "know" when to eject; but hesitate to take action because of an inadequate knowledge of procedures and an anxiety produced by unfamiliarity with the ejection experience. Ejection training in the Air Force is inadequate and needs to be improved. (Authors' abstract)

666

Flight Safety and Encephalography (Seguridad de vuelo y encefalografía). L. A. GARCÍA VILLALOBOS.—*Aviación* (Lima), 24 (381):36-41. July 1960. In Spanish.

Electroencephalographic examination of pilots and flying personnel is of value in detecting cerebral lesions, thereby minimizing the risk of aircraft accidents. The electroencephalogram is also capable of detecting changes in cerebral activity caused by hyperventilation, hypoglycemia, hypnotic and other drugs, intense sensory stimuli, anxiety, fear, increased carbon dioxide tension, and flight fatigue. It is recommended that the EEG be incorporated in the medical examinations for pilot selection and in the periodic medical screening of personnel for the appearance of latent conditions.

667

Age of the Aviator-Objective Evaluation Test (Preliminary Communication) (Wiek pilota-próba obiektywnej oceny [doniesienia wstępne]). J. HORNOWSKI, W. KRAMARZ, W. PAWLICKI and J. PODGÓRSKI.—*Lekarz wojskowy* (Warszawa), 36 (1):12-17. 1960. In Polish, with French summary, (p. 17).

A proposal is made that the biological age of man be determined by physical examinations, compared with chronological age, and a designation assigned as to "younger" or "older" in comparison with the chronological age. Using this method, 1,000 pilots were examined and found to be "older" than their chronological age (aging was more rapid). This test may be used in the elimination of pilots over 29-30 years of age from flying. (Authors' summary, modified)

668

Role and Importance of the Flight Surgeon in France with Regard to Air Safety (Rôle et importance du médecin de l'air en France dans la sécurité aérienne). MARCHESSEAU and FABRE.—*Revue internationale des services de santé des armées de terre, de mer, et de l'air* (Paris), 34 (1-2):21-24. Jan.-Feb. 1961. In French, with English summary. (p. 21).

The flight surgeon's role in the prevention of aircraft accidents is emphasized. He is responsible for selecting the best possible candidates for flight training by means of psychological and physiological examination; for indoctrinating candidates in flight physiology and human limitations during flight; for recommending and supervising regulations for mental hygiene; for co-operating with human engineers in aircraft design; and for training candidates in the use of protective equipment.

669

The Sex Ratio of Offspring of Pilots of High Performance Military Aircraft. R. G. SNYDER.—*Human Biol.*, 33 (1):1-10. Feb. 1961.

Data were obtained on 236 married pilots representing the total military population at three different military airbases. One hundred and eleven of these individuals fathered 222 children, 113 males and 109 females. It was found that there was a statistically significant preponderance of female offspring born when fathers flew fighter type aircraft prior to conception. Of 94 children conceived and born under such conditions, 59 were females, while only 35 were males. This results in a sex ratio of only 59.3, compared to an expected ratio of 105.37. It was also found that the relationship of parity (birth order) to the sex ratio agreed with the expected when the fathers flew transport types of aircraft or did not fly prior to conception; but a significant reversal of this relationship occurred when fathers flew fighters prior to conception of each child. This study gives statistical support to the hypothesis that the secondary ratio is significantly altered toward a preponderance of female offspring when the fathers have participated in high stress fighter-type flight prior to conception. (From the author's summary)

670

On the Subject of Personality: Favorable and Unfavorable Personality Traits of Airplane Pilots (In tema di personalità: attributi caratterologici favorevoli e sfavorevoli nel pilota di aviazione). M. STROLLO.—*Rivista di medicina aeronautica e spaziale* (Roma), 24 (1):55-70. Jan.-March 1961. In Italian, with English summary. (p. 69).

In a questionnaire presented to a group of pilots on active duty, it was demonstrated that a positive

association existed between flight performance and the favorable personality traits of practicality, calmness, sociality, decisiveness, and self-assurance, as opposed to a negative association with such unfavorable traits as abstractedness, nervousness, over-reactiveness, conformity, and submission.

Survival and Rescue

671

Some Problems of Providing Life Support Conditions in Cosmic Flight (Nutrition, Water Supplies, Air Regeneration, Sanitation) (Nekotorye voprosy obespecheniia uslovii zhiznedeiatel'nosti pri kosmicheskom polete (pitaniie, vodoobespechenie, regeneratsiia vozdukh, assenizatsiia)). A. A. GIURDZHIAN.—*Uspekhi sovremennoi biologii* (Moskva), 51 (1):74-83. 1961. In Russian.

This is a review of research on various aspects of life support conditions for space travel: closed ecological systems, control of the cabin atmosphere, nutrition, water recovery and recycling, toxicology, etc. American sources are employed almost exclusively. (47 references)

672

Causes and Mechanism of Injuries During Parachute Jumping (Przyczyny i mechanizm urazów w czasie skoków ze spadochronem). J. JEZ.—*Lekarz wojskowy* (Warszawa), 36 (10):992-999. 1960. In Polish, with French summary. (p. 999).

A statistical analysis is presented of the causes and mechanisms of injuries observed in 15,000 parachute jumps. The percentage of lesions was very small in comparison to those cited in other publications—not more than 0.4%. The number of injuries during unscheduled jumps was ten times greater than during scheduled jumps. Injuries were sustained around the ankle and knee and occurred during landing (70%). The right leg was injured more often than the left. Frequency and severity of the lesions increased with age. Adequate training of a parachutist plays a major role in the reduction of injuries. (Author's summary, modified)

673

The Human Factor, Cause of Flight Accidents (Il fattore umano, causa di incidenti di volo). T. LOMONACO.—*Rivista di medicina aeronautica e spaziale* (Roma), 24 (1):5-28. Jan.-March 1961. In Italian, with English summary. (p. 26-27).

Human factors account for 45% of all flight accidents. Major causes are attributed to (1) psychophysiological unfitness of flying personnel or of ground and traffic-control personnel; (2) the general physio-

logical effects of decompression, high speed, accelerations, vibrations, temperature and humidity changes, etc., encountered during flight; (3) operational fatigue; and (4) deficiencies of aptitude or flight training. The prevention of such accidents is based on (a) the control of flying personnel, both at the time of selection and during active service by periodic check-ups, and (b) the indoctrination of flight personnel on the principles of flight physiology and human limitations. The collaboration of the flight surgeon and the aviation engineer in the design of aircraft and flight equipment may serve to minimize the severity of injuries acquired during accidents.

674

Air Rescue Service in Italy (Il servizio di soccorso aereo in Italia). A. SCANO.—*Rivista di medicina aeronautica e spaziale* (Roma), 24 (1):71-81. Jan.-March 1961. In Italian, with English summary. (p. 80).

The organization and activities of the Italian Air Rescue Service are described. Its chief mission is to transport and rescue wounded and sick patients and persons involved in aircraft accidents and other types of disaster. Amphibious aircraft and helicopters are used.

Operational and Human Engineering

675

Cockpit Design Studies: Standard Cockpit Mockup, Pressure Suit Mobility. II. The Project Mercury Suit. N. M. BURNS and R. L. BURDICK.—Naval Air Material Center. Air Crew Equipment Lab., Philadelphia, Pa. Report no. NAMC-ACEL-443, Feb. 21, 1961. iv+10 p.

Unclassified

Six astronauts wearing pressure suits, seated at a modified Mercury control panel, received 25 sequence stimuli (involving groups of 6 switches or controls) and about 50 single stimuli (involving only a simple response to one light). Reaction times were tested under two conditions of pressure suit inflation: 0 p.s.i. and 5 p.s.i. Under the 5 p.s.i. condition, reaction times increased significantly as did the frequency of inadvertent actuation (i.e., errors).

676

Anthropometric Photogrammetry as Applied to Escape Capsule Design. J. W. CHAFFEE.—*Human Factors*, 3 (1):36-52. March 1961.

An experimental investigation was made of the location and spatial requirements of salient anatomical features of the human operator of a high-performance air weapon system when simulating the use of an escape capsule type of emergency abandonment system. Twenty-four subjects representative of the Air Force

flying population were measured using a new system of anthropometric assessment which employs a non-stereographic photogrammetric treatment requiring two to three ordinary 8-in. x 10-in. view cameras together with adequate stroboscopic illumination. Data on the x, y, and z co-ordinates of sixteen anatomical features of the operators when positioned in six body attitudes representative of the escape system's use are presented in the form of figures. (Author's abstract)

677

COED—A Device for the Experimental Study of Man-Machine Systems. R. H. JOHNSON, D. A. GORDON, B. BERGUM and W. E. PATTERSON.—*Human Factors*, 3 (1):60-65. March 1961.

A description is given of an experimental facility for investigating man-machine system design problems. The facility is called the COED (Computer Operated Electronic Display). It combines a very large capacity cathode ray tube (Digitron) with a high-speed computer (IBM 704). This device may be used to simulate very broad classes of man-machine systems. It provides programmed feedback, in which the display changes as it would if controls of the actual system were activated. The components of the COED simulator, as well as its programming and uses, are briefly described. The device may be employed to solve problems of allocation of function (man-machine), and those involved in the design of controls, displays, and procedures of use. (Authors' summary)

678

Operational Sequence Diagrams in System Design. M. I. KURKE.—*Human Factors*, 3 (1):66-73. March 1961.

Operational sequence diagrams (OSD) pictorially display information-decision-action sequences within a man-machine system. In its various versions as a time-sequence process chart, a spatial flow chart, and as an adjunct to symbolic logic, the OSD can be used in establishing system requirements, allocating man-machine functions, determining sequence of operations, and in evaluating equipment layouts. (Author's abstract)

679

A Technique for Evaluating Man-Machine System Designs. A. I. SIEGEL and J. J. WOLF.—*Human Factors*, 3 (1):18-28. March 1961.

A computer-based method for digitally simulating the performance, in one-operator systems, of operators who possess various characteristics is described. The method is believed applicable for evaluating various system designs while the system is in the early design stage. Two operational tasks, landing an F4D aircraft on a carrier and firing an air-to-air missile, were simulated using the method. The predictions from the

model were compared with outside criterion data for the same tasks. The predictions are held to conform generally with reality and to be reasonable. The results of the two applications of the model were in general agreement. It is held that the model may be considered sound and may now be tentatively employed for comparative evaluation of alternative system designs or for predicting system performance. (Authors' abstract)

680

How to Make a Man Feel at Home in Space.

G. V. E. THOMPSON.—*Engineering* (London), 191 (4959):623. May 5, 1961.

Design requirements for the manned space capsule include provisions for: (1) satisfaction of basic human needs; (2) protection against unfavorable environments; and (3) adaptation of the passenger to the stresses associated with take-off, the weightless state, and landing. Brief consideration is given to the orientation of the pilot's couch, the use of seat belts, size and cushioning of the cabin, possible additional living quarters, oxygen, temperature and humidity levels, food provision, space suit design, and the difficulties associated with adequate protection against radiation.

Airplane and Space Cabins

681

Air Conditioning and Pressurization for Modern Commercial Aircraft. V. CHUN.—*Heating, Piping and Air Conditioning*, 32 (12):129-132. Dec. 1960.

A discussion is given of the air cycle and vapor cycle systems of the air conditioning, comfort conditioning, and pressurization systems used in DC-7C and DC-8 aircraft. The advantages of the air cycle method used in the DC-7C are the light weight of the equipment and its adaptability to use for cabin pressurization without the need for major equipment additions. The vapor cycle method used in the DC-8 is more efficient from a thermodynamic standpoint, requires less power to operate, and is also capable of providing dehumidification. Thermal research is being directed to the solution of structural heating problems posed by the arrival of higher, faster flying jet liners.

Protective Equipment and Clothing

682

Development of an Emergency Pressure Suit Coverall, High Altitude, Ventilation-Exposure Type CSU-5/P. David Clark Co., Inc., Worcester, Mass. (Contract AF 33(600)-36627); issued by Wright Air Development Division. Opera-

tional Support Engineering Division, Wright-Patterson Air Force Base, Ohio (Project no. 6336, Task no. 63619). WADD Technical Report no. 60-809, Nov. 1960. vi+9 p. Unclassified

Developmental prototypes of an emergency pressure suit, Type CSU-5/P, are described. Subsequent sizing of this coverall in the eight-size height-weight program was based on the fourth model (Size Large Long, PNS-848C). The development of this coverall presents an opportunity to consolidate the anti-exposure and altitude coveralls with a minimum penalty for weight, when used on a specific mission profile which requires protection at altitude, and exposure on land and water in cold climates. A review of the attempts to integrate the neck seal bladder and coverall, in conjunction with quick entry methods, indicates definite progress, but requires that modifications be considered. (Author's summary)

683

An Air-Ventilated Suit for Wear in Very Hot Environments. G. W. CROCKFORD, R. F. HELLON,

P. W. HUMPHREYS and A. R. LIND.—*Ergonomics* (London), 4 (1):63-72. Jan. 1961.

Fifteen men, wearing an air-ventilated clothing assembly, were exposed to an ambient temperature of about 81° C. The suit was ventilated with dry air (6-7 mm. Hg) at volumes between 283-707 liters/min. at temperatures between 30° C. and 37.8° C. At ventilating volumes of 424 liters/min. and over, the subjects were able to establish bodily thermal equilibrium in an hour, irrespective of the temperature of the air delivered to the suit. Thermal equilibrium was never achieved when only 283 liters/min. were supplied. In the interests of safety, it is recommended that such a suit in use ought to be supplied with dry air at a volume of not less than 707 liters/min. at a temperature of not more than 30° C. (Authors' abstract)

684

Physiology and Operational Comparison of MC-1 and MC-3 (MC-4) Partial Pressure Suits. T. F. MCGUIRE.—Wright Air Development

Division, Aerospace Medical Division, Biomedical Lab., Wright-Patterson Air Force Base, Ohio. (Project no. 6333, Task no. 63612). WADD Technical Report no. 57-536 (I), Oct. 1960. vi+37 p. Unclassified

A theory on the physiological limitations of partial pressure suits, with supporting evidence, is discussed. Loss of "effective" blood volume, workload placed on the heart, available oxygen, a number of reflexes that can work separately or together to the individual's disadvantage, and other contributory mechanisms are stressed. The comparative operational characteristics of the MC-1 and MC-3 (MC-4) partial pressure suits are presented. (Author's abstract) (138 references)

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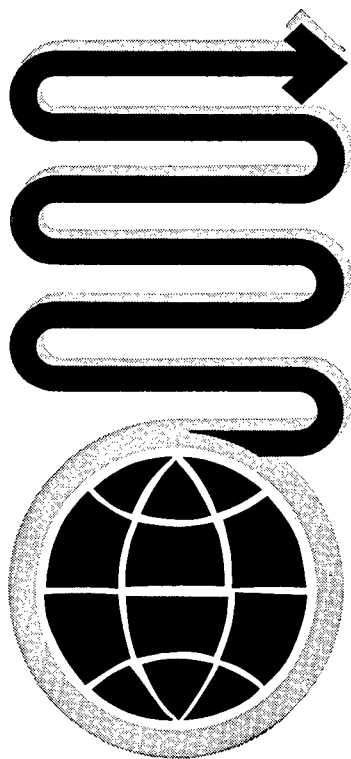
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